TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. IX No. 11. NOVEMBER, 1932. PRICE 6d.

CONTENTS.

	PAGE.
The Heritage of Science	329
Books Received	330
The Biological Control of Cane-Grubs ..	331
Empire Fibres	333
The Cacao Industry of Trinidad	334
Studies in Tropical Land Tenure	346
Observations concerning the healthiness of Coffee trees in Costa Rica	350
Manuring Bananas	352
Teosinte	352
Reviews	353
Sugar Notes	354
Chemical Notes	355
Trend of the Markets	356

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.
Cables :: "Stomata." | Phone :: 2183.

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

THE HERITAGE OF SCIENCE.

It is generally admitted that the most striking difference that characterises present-day conditions as contrasted with those which obtained in previous eras is the almost miraculous power that science, applied particularly to industrial processes, has now given to man. Since the time when Watt constructed the first successful steam engine, only one hundred and fifty years ago, very rapid changes have been going on in the pace and conditions of life, and a complete alteration has ensued in the industrial, social and economic aspects of the problems that affect the inter-relationships between men and nations. The nineteenth century produced the first germs of industrial revolution. To the inventive geniuses of that period we owe steam locomotives, motor-cars, steel ships, power looms, electric dynamos, arc-lights, harvesters and binders, telephones, cameras, gramophones, typewriters, fuel gases, anaesthetics, antiseptics, and artificial manures, and to-day, aeroplanes, cinemas, wireless telegraphy and poison gases are commonplaces. Furthermore, we read that the looms of Lancashire can now turn out in a week, cotton goods sufficient to meet a year's home demands. This vast development in mechanical efficiency has created entirely new economic problems. Thus, to take an example from agriculture, the introduction of the reaper and binder into wheat-growing has effected a diminution in the labour requirements of a typical Canadian farm from some thirty men employed in the spring, and some one hundred and twenty men employed at the harvest, to only fourteen men needed throughout the year. Thus, the use of each of these combined implements has deprived at least five men of harvest work. This has reacted on transport of labour gangs, and no west-bound harvest trains have been run in Canada for the past two years. Furthermore, it has been computed that the introduction of labour-saving machinery into American industries has increased the output per man during the ten years period, 1919 to 1929, by forty-five per cent., and has thus reduced employment from nine millions to just over eight millions. Such displaced workers have been able for a time to find employment in the creation of still further labour-saving machinery, but the process of reabsorption presumably cannot continue indefinitely, unless, indeed, a new system of working and living is created, whereby more human leisure is available, and the products of industry become accessible to a greater number of individuals.

In a stimulating article in *Chemistry and Industry* for June 24th, 1932, the Editor refers to a recent classification of human activity, based on the extent to which the products of different classes of activity may be over-produced. Firstly, over-production may occur with foods, clothing and luxuries, directly supply exceeds *immediate* needs; secondly, it may occur with houses, manufacturing-plant and transport, so soon as supply exceeds the needs of the *near future*; thirdly, it may occur with railways, roads, and public works when production exceeds the *ultimate* need. With education, scientific research and the arts, however, over-production can *never* occur. If this view be accepted, then "the distortion and misdirection of our productive activities becomes apparent." Again, to quote freely, if the free capital which accumulated out of profits of new industries that could not absorb it, had been devoted to the endowment of education and scientific research, instead of to investment in old industries liable to over-production, then our present manner of living and working would already have been largely ameliorated and improved. It is urged, therefore, that education and research should form the foundation of future progress.

It is the heritage of scientific discovery that has now made it possible, and in the future will make it even inevitable, for man to enjoy additional leisure. To no one individual or group of individuals can the marvellous achievements of the last century and a half be attributed; for no man can do more than focus the ideas he has inherited from the past, and all have the right to a share in the products of industry and research. In an ideal community, every man would receive such proportion of the continually increasing wealth which is his due as inheritor of the accumulated resources of the past.

In agriculture, the effects of scientific discovery, though perhaps not so spectacular and obvious as in the case of certain other industries, have nevertheless been very far reaching. It is only thirty-four years ago that Sir William Crookes, in his famous address to the British Association for the Advancement of Science, predicted a serious world shortage of wheat in 1932. This prediction was based on two suppositions, namely, that agricultural land suitable for the raising of wheat crops was limited in extent, and that available wheat lands would rapidly become infertile because of a threatened exhaustion of the great Chilean nitrate deposits.

It is very evident that Crookes' prophecy has not been fulfilled; there is nowadays no apparent shortage of wheat, nor is any shortage threatened. On the contrary, there is an over-production of wheat in the world. The causes that have alleviated the expected depression are based directly on the results of scientific discovery. Firstly, the development of systems of transport, such as efficient railways and road vehicles, as well as transport machinery, has brought about a rapid opening up of new virgin lands, particularly in the prairie regions of North America. Secondly, the great synthetic nitrogen industry has made possible the cheap manufacture of suitable manures in ever-increasing quantities. In addition to these fundamental improvements, rapid strides have been made in the mechanisation of tillage and reaping operations, so that the costs of wheat production have been greatly diminished. Thus, the chemist, the engineer and lastly the biologist have been active in effecting improvements; nor have their activities been confined to wheat production alone. Most other agricultural staples have benefited from their combined attention. Indeed, the world was never better and cheaper fed than it is to-day. Improvement has been slow, and in most cases gradual developments have occurred, and success has been achieved without acclamation, and almost without notice.

The effect of scientific method on the practice of agriculture has been reflected during the past twenty or thirty years in the ever-increasing demand for systematic agricultural teaching, as well as for further scientific research in all the branches of agricultural science, especially plant-breeding, soil management, manuring, animal husbandry and farm mechanics.

Agricultural education and research will doubtless receive their due measure of support in the promised brighter future, when a re-orientation of human endeavour has been achieved. The land and the open air are ever likely to attract a large proportion of mankind, for the growing of plants will always claim its devotees, whether their labours are spent for profit or for pleasure.

BOOKS RECEIVED.

We acknowledge with thanks the receipt of the following books which have been presented to the Library:—

CHEMISTRY.

Robinson, G. W.—Soils: their Origin, Constitution and Classification. *Thomas Murby & Co.* London, 1932. £1 0*s.* 0*d.*

GENERAL.

Stamp, L. and Newman, A.—Geography of the West Indies, Books I, II and IV. *Longmans Green & Co.*, London, 1932. 1*s.* 4*d.*, 1*s.* 6*d.*, 2*s.* 3*d.*

Taylor, H. E.—Wonders of the Earth's Crust. *Sir Isaac Pitman & Sons, Ltd.*, London, 1932. 2*s.* 6*d.*

ZOOLOGY.

Jaeger, E.—Dictionary of Greek and Latin Forms used in Zoological Names. *Bailliere, Tindall & Cox*, London, 1931. 8*s.* 6*d.*

Lister, H.—Aids to Zoology. *Bailliere, Tindall & Cox*, London, 1929. 3*s.* 6*d.*

THE BIOLOGICAL CONTROL OF CANE-GRUBS.

By E. Jarvis,
Entomologist, Department of Agriculture, North Queensland.

Introduction.

The method of combating insect pests by enlisting the services of their various parasitic or predaceous enemies is one which has always appealed very strongly to farmers as being an ideal remedy; the responsibility of which disappears when shifted to the shoulders of numerous diversified forms of insect life. Many of the most destructive insects still continue to defy the combined efforts of economic entomologists, and, even at the present day, the amount of damage to food products which a single species of primary importance will effect often runs into millions of pounds sterling.

In these days of scientific research, the activities of root-eating grubs of Scarabaeid beetles such as the European "May Bug" (*Melolontha sp.*), the Australian "grey-back" cock-chafer (*Lepidodermum albohirtum* Water.), and larvae of the genus *Lachnosterna*, which inflict such tremendous losses in parts of America and the West Indies, constitute a very serious menace, which of late years has necessitated the establishment of numerous well-equipped laboratories, staffed with specially trained scientific experts. In my description of the white grubs occurring in North Queensland cane-fields (*Tropical Agriculture*, Vol. VI, No. 10, 1929, pp. 276-278), no allusion was made to methods for destroying these pests, although in addition to the study of soil fumigants, the question of controlling the grey-back cane-beetle biologically had also received much attention.

In the West Indies, *Lachnosterna* (*Phytalus smithi* Arr.) is responsible at times for considerable damage to sugar-cane; control methods in Barbados consist chiefly in collecting the grubs and pupae of this insect, which is said to afford temporary relief. Similarly, the cane crop in Barbados is vigorously attacked by the larvae of a weevil-borer (*Diaprepes abbreviatus* L.) which occasionally cause severe root damage. In Puerto Rico, from 25 to 50 per cent. of the white grubs collected are said to be of this species; while in Barbados, *Diaprepes abbreviatus* is still a notable cane pest, for, as late as 1929, it was reported by Tucker to cause losses estimated at five to six tons of cane per acre.

The object of the present paper, however, while alluding very briefly to certain well-known Scarabaeid grubs destroying sugar-cane in the West Indies, is mainly to record personal experiences in connection with the breeding of Scoliid parasites, and methods employed when handling their life-cycle stages under laboratory conditions.

A Simple Method of Breeding Digger-Wasp Parasites.

Wasps belonging to the family Scoliidae are particularly interesting from a scientific standpoint, on account of their large size, their docility in captivity, and the important part played by many of the species in checking the increase of destructive Lamellicorn beetles.

Life-Cycle of a Digger-Wasp.

With regard to the habits of digger-wasps, it is well to mention briefly here, for the information of cane growers, that the adult female parasite, after locating the position of a grub by tapping the surface of the ground with its antennae, sets to work to dig downwards through the soil, and upon reaching its prey, stings it in the throat in such a manner as to paralyse and render it helpless. After laying out her victim in a convenient position, and affixing a single egg to the under surface of its body, the parasite returns again to the upper world to search for more grubs. Three days later, a tiny maggot hatches from the egg, bites a hole through the skin of the host, and inserting its mouth parts, commences to suck out the living body juices (Fig. 1). In less than a fortnight, it has become a white shining maggot an inch or more in length; then spins a brown oval cocoon of silk, inside of which it transforms to a pupa (Fig. 1a). A period of about forty days now elapses before the adult, fully-developed wasp finally escapes from this cocoon, and, tunnelling to the surface, starts its life's work (Figs. 2 and 3).

How to obtain the Eggs of Scoliidae.

Owing to oviposition of these insects taking place in the ground under moist conditions and in total darkness, it is necessary to duplicate such natural surroundings as far as possible in the breeding-cage. After experimenting with various types of cages, the best results were ultimately obtained by using a cage made of stout tin about five inches high by four in diameter. Provision for ventilation is supplied by a circular piece of copper gauze of about four inches in diameter forming the centre of the cage cover (Fig. 4). The soil used for wasp cages should be sieved through an eighth-inch mesh sieve, steam sterilized, and made adequately moist.

To prepare a breeding-cage, place in the bottom of the tin about an inch depth of slightly consolidated soil, and make a small concavity in it against the side of the tin with the second joint of a bent forefinger. After placing an active grub in this depression, cover it over with a couple of cakes of earth, made compact by pressing against the palm of the hand, thus enclosing the grub in a rough kind of cell. About three inches of soil can now be added, and gently pressed in such manner as to secure less firmness of soil near the surface than obtains at the bottom of the cage.

Before introducing the female parasite, prepare a mixture of honey and water (about half and half), and put a couple of drops on the surface of a leaf laid on the top of the soil. The leaf chosen should not have a polished surface, but be of a kind which will hold the liquid well when handled, and one free from objectionable odour. In response to such treatment, it may be stated that specimens of *Campsomeris tasmaniensis* have been kept alive for periods of 48, 51, and 75 days, the number of eggs laid by each specimen respectively being 34, 65 and 25. These wasps, in order to maintain normal health, do not apparently require more time on the wing than elapses every twenty-four hours while a cage is being emptied, the paralysed host with egg removed, and the soil again returned over a fresh normal grub. At the expiration of such period, another leaf with food is supplied and the wasp again confined. Such examinations should, if convenient, be made between 10 and 11 a.m. When emptying a cage, it should be held in tilted position while the soil is gradually loosened with some blunt tool and allowed to fall out. Upon breaking into the cavity enclosing a grub and exposing an egg to view, loosen the soil, and, grasping one leg of the host with a forceps, lift out the grub carefully to prevent the egg from touching the surrounding soil.

Collecting the Grubs.

Whilst collecting grubs in the field for this work, those grubs showing injury by the plough should always be rejected. Each specimen exhibiting normal activity must be placed as soon as possible in a separate cage of soil; as when confined together at close quarters, the grubs are likely to bite one another. The grub-cages should be made of tin about 3 inches high by 2½ inches in diameter, and, in order to retard evaporation of moisture from the soil, the metal top must not be perforated (Fig. 5).

Care of Eggs and Larvae.

Before transferring parasitized grubs to the breeding-tray, they should be carefully examined with a strong pocket lens for the presence of Acarid mites. These mostly occur amongst the mouth parts, leg joints, and in the deep wrinkles forming the joints of the first few abdominal segments. All mites noticed may be easily removed by the wet point of a small sable brush. A good form of tray for storing paralysed grubs may be made from ½-inch hardwood, a convenient size being 10 inches by 14 inches by 3 inches. The upper edges of this tray are planed level, and on them rests a sheet of glass as cover. The tray is filled to within about an inch of the top, with moist soil previously passed through an eighth-inch mesh sieve and slightly consolidated by pressure. By means of a wooden die (Fig. 6), rows of concavities are now impressed in the firm soil, of size about ½ inch broad, 1¾ inch long, and ½ inch deep. About six of such rows (36 cavities) will be found a convenient number. A grub is laid on its back in each depression, the maggot of the parasite lying during growth on the ventral surface of its host (Fig. 7). An inspection for mites should be made every day. Indication of possible premature death of the grub, either before or just after hatching of the egg, is betrayed by the cessation of movement of the mandibles and maxillae. On the first sign of blackening of the thoracic segments, such grubs should be destroyed, and the surface of the empty cell closely examined for signs of Acari. Metal labels marked with the number of each egg will serve for purposes of reference. While in the trays, paralysed grubs are subject at times to attacks of entomogenous fungi and bacterial diseases, which attack both eggs and larvae of Scoliid wasps (Fig. 8).

The Wasp Maggot and its Cocoon.

Larvae of these parasites attain their full size in about seven to ten days after emergence from the egg. A few hours before a specimen withdraws its head from the shrunken victim, it should be covered or roofed over in order to provide a place of attachment overhead for the silken envelope, which is to enclose the cocoon and pupa of the future wasp. A piece of tin or cardboard about 1½ inches square, and bent across the middle to form an angle of 60 degrees, serves the purpose very well when placed over the grub lengthwise (Fig. 7). After allowing three or four days for the cocoon to harden properly, lift up this temporary cover, remove any decaying portions of the grub, and transfer the cocoon to a specially prepared paper carton. This can be made as follows:—Take a strip of thick writing paper about 2½ inches wide by 12 inches long and roll this into a tube about ⅜ of an inch in diameter. Tie up one end, and make about six longitudinal cuts a quarter of an inch long around the edge of the other end. After inserting the cocoon (posterior end first) bend over at right angles towards the centre of the tube, the flaps made at the edge of the open end to close it. These cartons are best kept in a tin receptacle of suitable size, with a layer of moist sand in the bottom, a glass test-tube being inserted through one end about level with the sand, and having the recurved edge of the mouth caught inside against the hole in the tin, while the projecting portion outside serves to reveal the emergence of wasps from the enclosed cocoons. On the outside of each carton, the number of the specimen and the date of spinning of the cocoon should be marked in water-proof ink for future reference.

Notes on the Rearing of Scoliid Pupae.

The storage of cocoons in paper cartons (which may be claimed to have been originated by the present writer) would appear to be the most successful method so far tried of securing an emergence of practically one hundred per cent. of wasps; owing presumably to the absolute control afforded during the course of this critical life-cycle stage of development, which occupies a period of from one to two months and is passed at a depth of several inches in the ground. The best conditions to maintain in the storage tin are dampness varied occasionally, as the degree of moisture present may indicate, with a day or

THE BIOLOGICAL CONTROL OF CANE-GRUBS.

FIG. 1.—*Eggs and Young Larvae of "C. tasmaniensis," attached to paralysed cane-grubs lying in breeding-tray.*

FIG. 2.—*Maggot of Digger Wasp, about to spin its cocoon.*
Cocoon of Wasp, a little smaller than natural size.

FIG. 2A.—*Maggot of Digger Wasp, showing segmentation of same, together with photo of half grown maggot.*

FIG. 1A.—*Cocoon of Digger Wasp cut open to show the pupa inside. Natural size.*

FIG. 3.—*Digger Wasp Parasite "Campsomeris tasmaniensis," Sauss. Natural size.*

THE BIOLOGICAL CONTROL OF CANE-GRUBS.

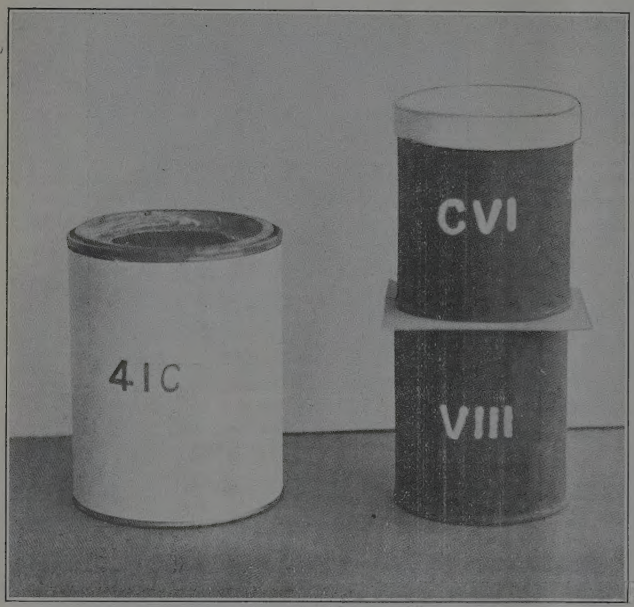


FIG. 4.—*Cage containing Host Grub to be attacked by Wasp Parasite. About one-third natural size.*

FIG. 5.—*Tins for storing Grubs intended to be used as Hosts. About one-third natural size.*

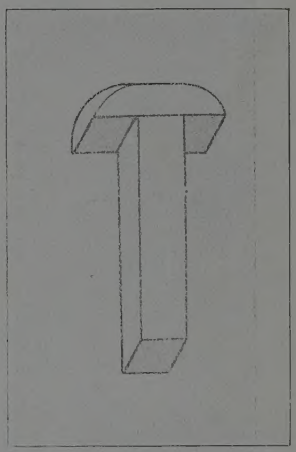


FIG. 6.—*Wooden Die, for making concavities in the soil of a breeding-tray for the reception of paralysed cane-grubs. Half full size.*

FIG. 7.—*Portion of the surface of a breeding-tray, showing eggs, cocoons, and covers over spinning maggots of "Campsomeris tasmaniensis".*

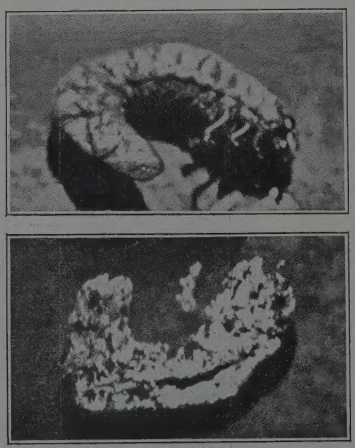


FIG. 8.—*"Grey-Back" Grubs killed by Fungus "Metarrhizium anisopliae" Metsch. Sor. (a) Early and (b) Final stage of development of fungus.*

two of dryness. To secure these conditions, one only needs to throw out the moist sand or soil, allow the cartons to dry, and then replace the material in the storage tin for a few hours before supplying additional moist sand. It will be found a good plan to inspect each cocoon at intervals of a week or so for the presence of mould or entomogenous fungi. Any cocoons blackening at one end, or appearing to be wet, must be immediately transferred to a new carton and allowed to dry for a couple of days before again being placed under damp conditions. Cartons showing evidence of becoming mouldy on the outside should always be changed. In cases where the pupal condition of a Scoliid wasp happens to exceed two months duration, or when specimens of an autumn brood appear likely to over-winter as pupae, it is advisable to provide ventilation in the storage tin, by replacing a portion of the bottom by copper gauze.

Controlling Mites infesting the Eggs and Larvae of Scoliidae.

In addition to the hand picking of Acari already mentioned, injury from mites may be avoided or reduced to a minimum by selecting the grubs intended to serve as hosts from soils in which mites chance to infest only a negligible percentage of the grubs present in them. The writer has obtained satisfactory results by this method of procedure, securing in some instances an immediate decrease in mortality of sixty to less than ten per cent.

Preparation of Breeding-Trays.

It is very important that the soil in breeding-trays should not be allowed to become too moist, or trouble will sooner or later result from the presence of fungi. Such conditions are betrayed by excessive condensation of moisture on the lower surface of the glass cover, which is very noticeable in the early morning. Should this occur, the glass sheet must be so placed as to allow air freely to enter the tray for a few hours. When eggs and young larvae of the parasite chance to be present, such entrance of dry air should be arranged, however, so as to take place at a point as remote as can be managed—or covers of small Petrie dishes may be placed over host-grubs to maintain damp conditions around any eggs or tiny maggots.

EMPIRE FIBRES.

The Imperial Economic Committee in their twenty-fourth Report survey the fields of Empire production of hemp fibres, including East African and West Indian sisal and New Zealand, Indian and Mauritius hemps; and discuss the prospects of extending the use of these fibres for making ropes, cords and strings in the Empire countries.

The committee point out that a very large proportion of the hemp fibre prepared is used to make ropes for marine purposes, and that manila hemp is firmly established in this field. Although there is a small production within the British Empire—in British North Borneo and certain Pacific Islands—manila hemp is almost entirely produced in the Philippines, and there is no prospect of the Empire becoming self-sufficient in this fibre. The possibility of using Empire fibres for marine cordage is at present being tested, and the results to date have justified the tests.

The first uncertainty whether East African sisal and New Zealand hemp would effectively resist the action of sea water has been disposed of. Subsequent Admiralty trials have shown that East African sisal of a good grade not only has a greater initial breaking strain, "but compares favourably with manila when exposed under service conditions". The difficulties at present are that sisal absorbs water more quickly than manila and, therefore, weighs more and sinks more easily; that it swells more and shrinks in length more rapidly; and that when dried it does not return, like manila, to its approximate original size. Much larger tests, which will be completed this autumn, will give ground for a more complete judgment on the practicability of the general use of sisal for marine purposes.

So far the two great centres of the cordage industry in the Empire have tended to specialize in particular branches. The United Kingdom has specialized in large ropes and cables, particularly for marine purposes, and in consequence more than half its raw material has been manila hemp. The Canadian industry has specialised in binder twine, a commodity for which, because of the latest development in mechanized agriculture, there is likely to be less and less demand.

Nevertheless, a great field lies open for Empire hemp fibres, as the raw material for twines, cords, and small ropes, if production on scientific lines can ensure good quality at a cheap price. For these articles, providing they are sufficiently strong, durable, and flexible, cheapness is of chief importance. The low price of sisal in recent years has secured for it a new market here, and, the report says, "even an unobservant shopper must have noticed that the string with which her parcels are now tied is of a different sort from that used a few years ago".

In addition to East Africa, there are other countries in the Empire where the sisal industry, if small, is of importance, notably the Bahamas and Jamaica. In the Bahamas the necessity for establishing standard grades is now recognized, and the methods of marketing in Nassau also need revision.

In New Zealand, at one time the most important Empire source of hard hemp, there has been a serious contraction of exports. The committee advise an economic survey of the industry there, and the development of a station for cultural experiments. Mechanization might probably be pushed much further in New Zealand; and it is greatly to the interests of St. Helena, where the same fibre provides one of the principal exports, that its authorities should closely follow the progress made in New Zealand.

The development of the market for Indian hemp, which is almost the sole Empire source of soft hemp, calls for more careful preparation and better marketing of the fibre.

THE CACAO INDUSTRY OF TRINIDAD.

SOME ECONOMIC ASPECTS.

Part V.—Section III.

By C. Y. Shephard.

It has been observed that from 1920/1921 to 1923/24 the cacao planters obtained such low prices for their produce that Government was induced to provide temporary financial assistance. In 1924 financial aid by Government to the cacao industry was placed on a more permanent basis by the establishment of the Agricultural Bank. In the same year prices began to rise to more remunerative levels. From July, 1924, to June, 1925, an average of $19.50 (£4 1*s.* 3*d.*) a bag * was obtained for plantation cacao (14). During the next three years the average prices per bag were $18.75 (£3 18*s.* 1½*d.*), $22.88 (£4 15*s.* 4*d.*), and $21.75 (£4 10*s.* 7½*d.*), respectively (14). For a time it was hoped that the depression had ended, and that the low prices realised during the four years 1920/21 to 1923/24, had been merely an unpleasant interlude in a period of prosperity which would be continued far into the future. In 1928 prices began to fall, and the decline continued steadily until 15th June, 1932, when plantation cacao was quoted in Port-of-Spain at $9.00 (£1 17*s.* 6*d.*) a bag. The average prices for the four years 1928/29 to 1931/32 were $17.33 (£3 12*s.* 2½*d.*), $16.14 (£3 7*s.* 3*d.*), $11.40 (£2 7*s.* 6*d.*), and $11.03 (£2 5*s.* 11½*d.*), respectively, per bag (14). At the present time (October, 1932) the local price for plantation cacao is about $11.63 (£2 8*s.* 5½*d.*) per bag.

During the past two years prices have been well below the average cost of production. The data obtained during the present investigation showed that the 216 estates visited produced their cacao during the three-year period 1926/27 to 1928/29, at an average cost of $12.91 (£2 13*s.* 9½*d.*) a bag. During 1930/31 and 1931/32 the average prices per bag were $11.40 (£2 7*s.* 6*d.*) and $11.03 (£2 5*s.* 11½*d.*), respectively (14). Since the cost of production does not include interest on capital or mortgages, the situation is worse than these figures suggest. On the "best estates", totalling one-quarter of the total number, the cost of production was only $9.03 (£1 17*s.* 7½*d.*) a bag. On the other hand, the "worst estates", of a similar number, produced at an average cost of $19.06 (£3 19*s.* 5*d.*) a bag. In 1929/30 the average cost per bag on "all estates" was $13.17 (£2 14*s.* 10½*d.*), on the "best estates" $8.49 (£1 15*s.* 4½*d.*), and on the "worst estates" $24.89 (£5 3*s.* 8½*d.*). The "worst estates" lost an average of $9.21 (£1 18*s.* 4½*d.*) on each bag of cacao produced in 1929/30. Comprehensive statistics are not available for either 1930/31 or 1931/32. There can be little doubt, however, that low prices during both periods, and the exceptionally low yields during 1931/32, made it impossible for any but the very finest estates to produce at a profit. In general, cacao planters, mortgagees and labourers are experiencing a period of great distress for which there has been no parallel during the past hundred years.

The difficulties of cacao planters have been increased by the appearance of witchbroom (*Marasmius perniciosus*). This disease has caused considerable losses to cacao planters in Surinam (39) and Ecuador. The facts relating to the disease in Trinidad may be stated briefly. Witchbroom was first discovered in this island on a small-holding in Le Branche (Turure) in May, 1928, and shortly afterwards further infection was found in Tamana. Diseased twigs, cushions, and pods of all sizes were found. Although control measures were immediately advocated, and, to some extent carried out, the disease spread rapidly. At the end of 1929, the total area of cacao on properties where witchbroom had been discovered was 44,000 acres. This area increased to 86,700 in 1930, to 102,100 acres in 1931, and to 126,900 acres by June, 1932 (54). The disease is now present on properties which account for 60 per cent. of the total area of cacao in Trinidad. Every cacao growing district in the island is affected, but the incidence in the Northern Range is light, only the Tucker Valley towards the Western end, the Quare Valley towards the Eastern end, and, more recently, the Santa Cruz Valley, being affected.

There is a danger that exaggerated conclusions may be drawn from these records. The acreage refers to the total area of cacao on every property on which witchbroom is discovered, and not necessarily to the area definitely affected by the disease. For example, the discovery of a single broom on an estate containing 600 acres of cacao would add 600 acres, whereas a similar broom found on a small-holding of ten acres would add only ten acres to the recorded area. In both cases the great majority of the trees would be free of the disease. A better indication of the incidence of the disease is obtained by considering the intensity of the infection on these properties. If more than 50 per cent. of the trees have been affected the infection is described as "Heavy" if ten to 50 per cent., "Medium"; less than ten per cent., "Light"; and an occasional tree, "Scattered". On this basis, the infection was "Heavy" on 7,400 acres, "Medium" on 8,000 acres, "Light" on 12,000 acres, and "Scattered" on 99,500 acres (54). Thus, although the disease is present on properties which account for 60 per cent. of the total area of cacao in Trinidad, the vast majority of the cacao trees in Trinidad still remains uninfected. A few estates

* In Trinidad, cacao prices are quoted per fanega, and costs of production per bag. To facilitate comparison both prices and costs are here quoted per bag.

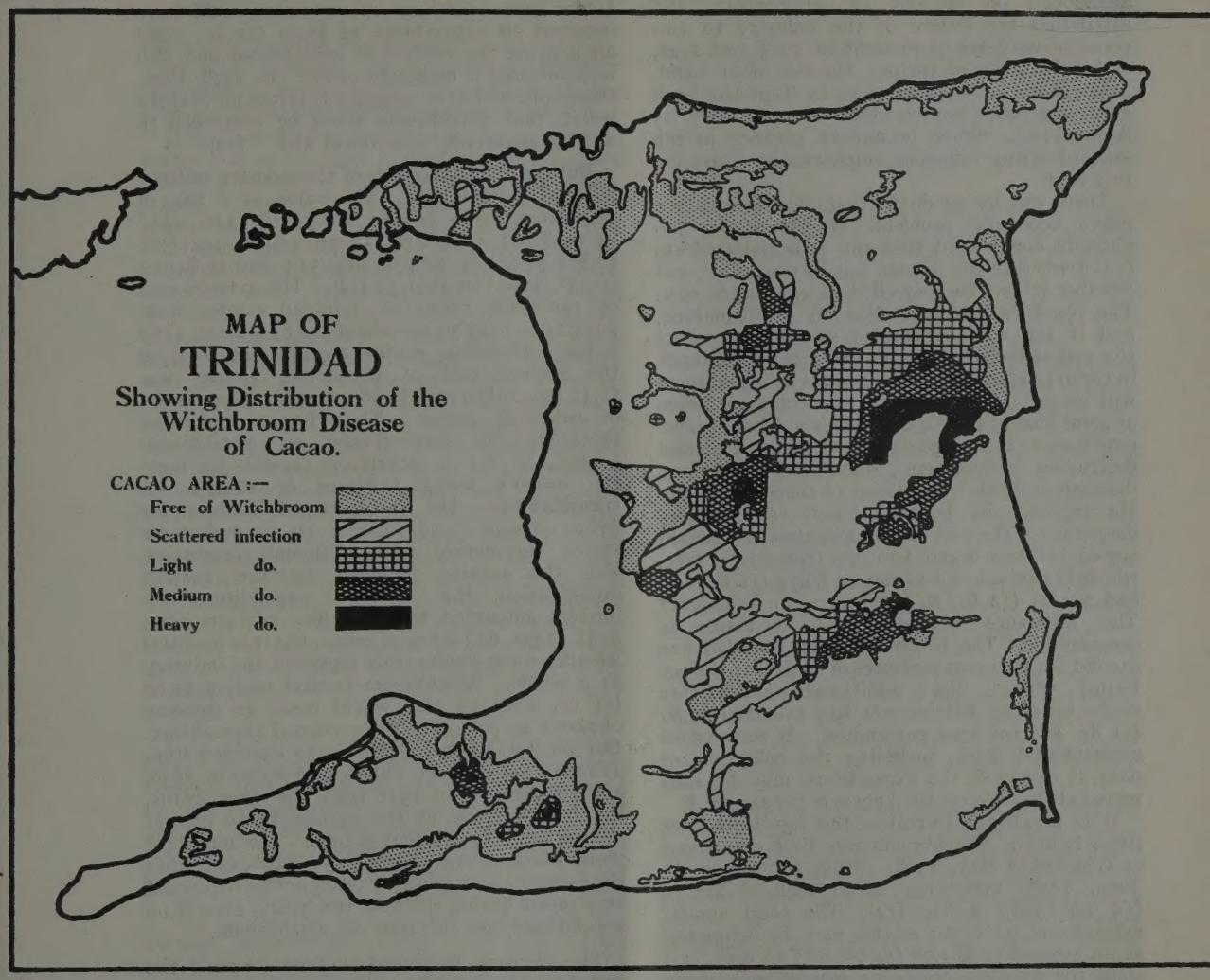


FIG. VII.—*This map shows the distribution of Witchbroom in June, 1932, and has been redrawn by permission from C. P. No. 76 of 1932.* (54).

have lost a large number of pods through witchbroom, but, considering the island as a whole, the loss of crop occasioned by this disease constitutes a very small fraction of the island's output. The present losses in yield caused by those pests and other diseases which have been established in Trinidad for many years, are far heavier. Nevertheless witchbroom is regarded as a far more serious problem because of the heavier losses it may occasion in the future. The existing measures for controlling witchbroom necessitate much heavier expenditure than pests and other diseases.

Several other aspects of the disease appear fairly well established. There is a general concensus of opinion that witchbroom cannot be eradicated (34), (59). Low-lying wet districts suffer the heaviest infection, while undulating land experiences a much lighter incidence even when in the near vicinity of centres of heavy infection (59). In some districts removed from the initial centre of infection the disease has made its appearance but has so far failed to spread at a rapid rate. The neighbouring island of Tobago is still uninfected. There is reason to believe that environmental conditions in certain areas are far less favourable to the development of witchbroom.

These facts and observations have occasioned the widest divergence of opinion regarding the future of the Trinidad cacao industry. Dr. Stahel, Director of Agriculture, Surinam, who inspected the infected areas at the request of the Trinidad Government, expressed the opinion that "witchbroom disease can be easily and thoroughly controlled without special machinery in a comparatively economical way" (34). He denied that the cacao cultivation of Surinam was

abandoned on account of witchbroom, and attributed the failure of the industry to two consecutive years of drought in 1925 and 1926, and to attacks of thrips. On the other hand, some large cacao proprietors in Trinidad have expressed the opinion that the industry is doomed (52). Other prominent planters in the area of heavy infection emphatically contradict this view.

There can be no doubt that witchbroom is a grave economic problem. It cannot be too strongly emphasised that the principal problem is not whether the disease can be controlled, but whether it can be controlled at reasonable cost. The planter's principal object is profit-making, and if the cost of control measures prevents the realisation of this aim the planter's interest in cacao production and the control of witchbroom will cease. It is therefore important to arrive at some idea of the expenditure involved. Stahel emphasises the importance of removing, and destroying witchbrooms, indurated pods, and diseased cushions every three to four weeks (58). He regards any longer interval as extremely dangerous. The cost of such measures in Surinam varied between 6 and 10 cents (Dutch) per tree, which is equivalent to between $6.72 (£1 8*s.* 0*d.*) and $11.20 (£2 6*s.* 8*d.*) per acre in Trinidad.* The difference between these estimates is considerable. The Government of Trinidad has carried out stringent measures of control at Marper Farm† where the additional expenditure necessitated by witchbroom has averaged $6.80 (£1 8*s.* 4*d.*) per acre per annum. If the cost of experimental work, including the collection of data, is deducted, the expenditure may be estimated at $5.00 (£1 0*s.* 10*d.*) per acre per annum.‡

It is important to realise the significance of these figures. Witchbroom was first discovered in Trinidad in May, 1928. From July, 1927, to June, 1928, plantation cacao realised $21.75 (£4 10*s.* 7½*d.*) a bag (14). The total annual expenditure on cacao estates may be estimated at an average of $21.00 (£4 7*s.* 6*d.*) an acre, and since the average income in 1927/28 was about $35.00 (£7 5*s.* 10*d.*) an acre, there was a surplus of $14.00 (£2 18*s.* 4*d.*) an acre. Even the "worst estates" showed a profit of nearly $3.50 (14*s.* 7*d.*) an acre. The total value of cacao exported from Trinidad and Tobago in 1928 was £1,651,169 (16). Under such conditions most estates could have incurred an expenditure of $5.00 (£1 0*s.* 10*d.*) an acre on the control of witchbroom and still have secured a moderate profit. In 1928, then, there appeared to be some justification for Stahel's belief, that witchbroom could be controlled in a "comparatively economical way" (34).

But the financial results of the industry suffered a rapid deterioration. The value of a bag of plantation cacao fell to $17.33 (£3 12*s.* 2½*d.*) in 1928/29; to $16.14 (£3 7*s.* 3*d.*) in 1929/30; to $11.40 (£2 7*s.* 6*d.*) in 1930/31; and to $11.03 (£2 5*s.* 11½*d.*) in 1931/32 (14). The average cost of producing cacao on Trinidad estates from 1923/24 to 1929/30 was about $12.81 (£2 13*s.* 4½*d.*) a bag. Therefore, during 1930/31 and 1931/32 the normal cost of production a bag was $1.41 (5*s.* 10½*d.*) and $1.78 (7*s.* 5*d.*), respectively, in excess of prices. These figures make no provision for expenditure on witchbroom control, or for a return on capital to meet the owner's living expenses or charges on encumbrances. The incidence of charges for living expenses and interest on encumbrances varies enormously with different properties. For the estates included in the present investigation, the average expenditure on interest amounted to $2.06 (8*s.* 7*d.*) an acre, or $1.32 (5*s.* 6*d.*) a bag of cacao, but it is doubtful whether these results truly represent the industry as a whole. Witchbroom control costing $5.00 (£1 0*s.* 10*d.*) an acre would mean an increase of about 20 per cent. in the normal expenditure. But the total value of the cacao exported from Trinidad and Tobago fell to £1,136,056 in 1930, and to £826,333 in 1931 (16). In other words, the gross revenue of the average cacao planter in 1931 was only half that of 1928. The important point which emerges from these statistics is that the average cacao property could not be conducted at a profit during the past two years, even if no expenditure was incurred on witchbroom.

The planters have endeavoured to meet the situation by reducing wages, and by exercising more careful financial control over the operations on their properties. These measures have resulted in a reduction in the costs of production. Most planters have been compelled to proceed a step further and to eliminate or curtail operations considered essential for the maintenance of efficiency. This expedient must eventually react upon yields. Living expenses have been reduced, and payments of interest on encumbrances have fallen into arrears. Most planters have incurred some expenditure in an endeavour to control the disease. The properties in the heavily infected districts have costs of production below the average, and this has enabled a number of planters to prosecute vigorous and systematic control measures, but in most cases these efforts have necessarily fallen far short of the standard recommended by Stahel. During 1931/32 the planters were further handicapped by a late and short crop, and conditions particularly

* This calculation is made on the basis of 280 trees to the acre, and a guilder being valued at 40 (Trinidad) cents, or 1*s.* 8*d.*

† This estate is situated in an area heavily infected by witchbroom. It formerly consisted of a number of small-holdings which were acquired by Government to enable experiments to be conducted in methods of control. It's name is derived from the first syllables of *Marasmius perniciosus*, the fungus responsible for witchbroom.

‡ If the same strict measures of control were maintained throughout the infected area, intensive infection from without would be reduced, and the cost of control measures at Marper would probably be less than $5.00 (£1 0*s.* 10*d.*) per acre.

favourable for the development of witchbroom. The crop handled by the Cocoa Planters' Association, for example, was one-third less than in the previous twelve months (14).

It is clear that unless there is a rise in cacao prices and an increase in yield few estates will remain profitable if heavily infected with witchbroom. There is good reason to believe that prices will rise. Low prices during the past ten years have discouraged and slowed down cacao planting throughout the world; considerable areas of cacao cultivation have already been abandoned; additional areas will soon go out of cacao cultivation; yields are diminishing on the older properties; consumption is expanding and stocks are contracting. The statistical position of cacao is favourable to a substantial rise in values, but prices are depressed by political and economic factors of world-wide character. The measures that would result in a world-wide economic recovery are fairly well recognised although little has been done to implement them. Nevertheless, there are certain indications of closer international co-operation in the attempt to remove existing obstacles to world prosperity. The writer believes that a definite improvement in world affairs would cause a substantial improvement in the price of cacao. It is probable that such a rise in price would be maintained for several years, for the supply of cacao is very inelastic.

It is impossible to predict either the date or extent of this rise in prices. It may be noted, however, that an expenditure of $5.00 (£1 0*s.* 10*d.*) an acre is equivalent to $3.17 (13*s.* 2½*d.*) a bag of cacao with the existing average yields of 260 lb. per acre. Consequently, even if other costs of production are reduced to $11.00 (£2 5*s.* 10*d.*) a bag, the price must exceed $14.17 (£2 19*s.* 0½*d.*) a bag before the average revenue exceeds the average expenditure. Even with such prices half the properties would fail to earn any profit if heavily infected with witchbroom. The fact is that the costs of production are so high on at least one-third of the estates for which the writer has records, that even if they remain entirely free of witchbroom they will be incapable of showing profits unless prices rise to about $20.00 (£4 3*s.* 4*d.*) a bag. Such a price is unlikely to be realised over any extended period. If the costs of production on the estates visited are representative of the entire industry, it is probable that a large acreage of cacao in Trinidad, which the writer estimates will be at least one-third of the total area, will be abandoned within the next few years. This reduction in area will not involve a corresponding reduction in the output of cacao because those properties with the highest costs are those with the lowest yields. The presence of witchbroom will accelerate the abandonment of these properties and involve others that would otherwise have remained profitable. The introduction of suitable alternative crops will also tend to reduce the acreage under cacao. There is little doubt, then, that the acreage under cacao in Trinidad will undergo a rapid decline, and that while this reduction will be caused primarily by excessively high costs of production, the expenditure involved in attempting to control witchbroom and the losses of crop occasioned by this disease, will definitely accelerate and extend the abandonment of such areas.

On the other hand, a price of $15.00 (£3 2*s.* 6*d.*) a bag would enable a large section of the industry (probably at least one-third) to remain profitable even in the presence of witchbroom. The cost of controlling the disease on these properties will represent only a small charge per bag of cacao because their yields are comparatively high. This may be illustrated by considering two extreme cases. If the yield is as low as one bag of cacao per acre the cost of control will be $5.00 (£1 0*s.* 10*d.*) a bag, but if the yield is as high as five bags of cacao per acre the cost of control will be reduced to $1.00 (4*s.* 2*d.*) a bag. Any measures which result in higher yields per acre will automatically reduce the cost of witchbroom control expressed in terms of a bag of cacao. It will be demonstrated later that properties with high yields have low costs of production, while properties with low yields have high costs of production. It would be erroneous to infer, however, that measures resulting in improving the yields of a property must invariably result in a reduction in unit cost, or an increase in the profit per acre. The higher yields of the "best estates" are largely due to more favourable natural conditions. It is important to recognise that increases in yield may be gained at excessive cost.

Nevertheless, experience clearly demonstrates the scope for more skilful exploitation of the conditions presented by many Trinidad properties, and suggests that a more intensive and consistent policy of cultivation would produce substantially greater profits. Moreover, the research work being conducted by the Imperial College of Tropical Agriculture, the Department of Agriculture, and individual planters, encourages the hope that additional means of increasing both yields and profits on favourably situated properties will soon be brought within sight. These investigations are of vital importance to the Trinidad planter, and it is essential that he should utilise such facilities immediately they become available, and that the means of accomplishing this end should be rendered intelligible and accessible at the earliest possible moment. There is reason to believe that, granted an average price of about $15.00 (£3 2*s.* 6*d.*) a bag, a large and increasing section of the industry will be enabled to secure reasonable profits despite the expenditure and losses involved by witchbroom. But these modifications in organisation and methods of cultivation cannot effect any change in the situation for several years, and satisfactory methods of meeting the present difficulties are most desirable.

The situation may be summarised as follows. Witchbroom has spread from the initial centres of infection at an extremely rapid rate, and is

now present on properties having a total cacao area of 126,900 acres of cacao. Properties with some 7,400 acres of cacao are heavily infected. There is no hope of eradicating the disease. Large areas of cacao appear to present conditions which are naturally unfavourable to the development and spread of witchbroom. The cacao planters in general have neither the means nor the credit facilities to combat the disease by more intensive methods of cultivation and strict methods of control. One-third of the area is so unprofitable that it cannot survive even if prices rise to unexpectedly high levels. The great majority of the cacao properties could not survive with present prices. There is reason to believe that a large section of the industry will remain profitable, despite the presence of witchbroom, provided that more intensive methods are pursued, that prices rise to about $15.00 (£3 2*s.* 6*d.*) a bag, and that the disease can be kept in reasonable check in the meantime.

The financial condition of the industry and of the Colony imposes strict limitations upon the measures which can be adopted to control the disease. Under these circumstances the writer considers that the following measures are the most satisfactory that can be employed for the present: strict control of the disease by planters up to the limit of their resources, periodic campaigns conducted by Government in the centres of heaviest infection, a comprehensive study of the disease and methods of control, and the provision of relief measures for the cacao planters. This, with certain minor modifications, represents the present policy.

The cacao planters are required by the Plant Protection Ordinance (57) to notify the Department of Agriculture of the presence of witchbroom on their properties, and to take such measures as are recommended to destroy all infectious material. A special administrative staff is maintained for the purpose of inspecting such properties and disseminating advice. The degree of control exercised on many cacao properties falls far short of the ideal largely because the owners do not command the means of putting the recommended methods into full effect. There are some proprietors, however, who adopt an indifferent attitude because either they fail to appreciate the gravity of the disease, or they have no faith in the existing measures of control. It is right and proper that the fullest pressure should be exercised on such individuals because their neglect endangers neighbouring properties.

Since the efforts of the planters are inadequate, and must remain so under existing circumstances, it is desirable that Government should undertake supplementary measures. Government intervention is necessary because it is the sole authority empowered to exercise control over every cacao planter, and without the exercise of such power the indifferent planter would prejudice the efforts of his colleagues. Government effort must be concentrated in respect of both area and time. In May and early June of 1932, the Department of Agriculture carried out an intensive campaign on about 7,000 acres of the most heavily infected cacao. One million trees, representing half the total number in this area, were found to be infected. All the diseased material discovered was removed and burned or buried at a total cost of $23,645.00 (£4,926 0*s.* 10*d.*) on labour, which is equivalent to $2.47 (10*s.* 3½*d.*) per acre (54). This expenditure is to be recovered by a levy, equivalent to one-third of the total cost, on the properties on which the work was carried out, and by a cess of 3 cents (1½*d.*) per fanega on all cacao exported from the Colony for 12 months commencing 1st October, 1932 (53).*

The month of May was selected as the date of the campaign for the following reasons:—the largest flush of brooms normally takes place in February and March; these brooms do not produce spores until fourteen or more weeks from their first appearance; spore dissemination is the only known means by which the disease can spread; the main cacao crop finishes about May; the rainy season usually commences at the end of May, and the routine pruning of the trees is begun during the same month (54). In consequence, an earlier start would have interfered with harvesting, and might not have covered the entire flush period, while a later start would have been dangerous on account of spore production, and inconvenient because of the commencement of the rains. The month of May has the advantage of enabling the planter to combine the elimination of diseased material with the operation of pruning.

This campaign will merely check the rate of spread of the disease and there is no hope that it will succeed in eliminating it. Seasonal conditions during 1931/32 were particularly favourable for the spread of the disease. If the 1932/33 season proves unfavourable to the disease there is a danger that planters may be encouraged to attribute the entire diminution in infection to Government's campaign, and to regard the danger as past. The campaign should be repeated each year to ensure that no heavily infected area is being grossly neglected, and that spore producing material is heavily reduced simultaneously over the focus of infection during the critical phase.

A comprehensive study of the disease is being undertaken with the object of evolving cheaper or more effective methods of control. Valuable information is being obtained from the experiments at Marper Farm, from the Agricultural Department's intensive witchbroom campaign, by the witchbroom inspectors, and by the planting community. Provided the staff responsible for these investigations is freed from routine administration, and thereby enabled to concentrate its entire energies on collecting, collating, and

* If "the market price of cocoa in Port-of-Spain is £2 1*s.* 8*d.* ($10.00) or more per fanega . . . the tax shall be 2½*d.* (5 cents) per fanega." The deficit, if any, will be met from General Revenue.

analysing the available data, and conducting experiments, it should succeed in devising cheaper or more effective methods of control, or in indicating means of increasing profits to an extent sufficient to meet the cost of control (9). It is estimated that a sum of $35,000,000 (£7,291,666 13*s*. 4*d*.) (12) has been invested in the cacao industry. Cacao occupies two-thirds of the cultivated area of the Colony and normally provides employment for more labourers than any other industry. It is generally regarded as a sensitive financial barometer of the Colony. The expenditure of a moderate sum on research of this nature may be regarded as a sound investment. The results of these investigations, whether positive or negative, must ultimately prove of great value to the industry.

It must be recognised that immediate results are unlikely and it is therefore essential that the existing methods of control should be pursued with vigour. The belief that the present methods are imperfect is no valid reason for neglecting such measures until the ideal is achieved. On the other hand, it is useless to expect that planters will carry out strict methods of control when they are unable to obtain sufficient credit for the maintenance of their estates. The remedy for witchbroom is said to lie in more intensive methods of cultivation and the systematic removal of diseased material (9). Low prices and inadequate credit have compelled the planters to adopt more extensive methods of cultivation, and to neglect the control of witchbroom. Government has considered it desirable to supplement existing sources of credit. In 1930 a special Committee was appointed to recommend measures which Government might undertake to assist the cacao industry (12). The Committee recognised that if inadequate credit facilities were granted the efficiency of the industry would be prejudiced, particularly in view of the presence of witchbroom. On the other hand, excessive credit would not only involve risk to Government funds but also increase the planter's burden of debts, and thereby hinder his subsequent financial recovery. The Committee's recommendations were framed with the object of attaining the following objectives in as complete a form as the conflicting elements render possible :—the maintenance of the industry on an efficient basis; the provision of regular employment for the normal complement of labourers; the restriction of loans to those properties considered economically sound under normal conditions; and the avoidance of undue risks to Government funds.

The Committee examined four proposals for financing the cacao industry and came to the conclusion that the most effective assistance would be provided by a modified form of the Agricultural Relief Ordinance (4). The proposed Cocoa Relief Scheme (12) differed from the previous measure by insisting upon a valuation of the property of the applicant, and by recognising the prior claims of existing encumbrancers of the land. The Committee recommended that advances should be made for the following purposes :—

(*a*) "To pay salaries and wages of employees engaged in the cultivation of the land.
(*b*) To meet interest on encumbrances subsisting or outstanding at the time advances are made,
(*c*) To purchase and maintain live and dead stock,
(*d*) To pay taxes and rates (Lands and Buildings) and insurance on buildings,
(*e*) To repay moneys which have been applied to the maintenance and cultivation of the land before advances are made by Government,
(*f*) For such other purposes as the Governor may deem necessary" (12).

It was suggested that interest on advances should be varied according to the price of cacao, and that no interest should be payable when cacao realised an average of less than $10.00 (£2 1*s*. 8*d*.) a fanega (*see* Table XX).

Table XX.

Proposed Rates of Interest to be charged on Advances under the Cocoa Industry Relief Scheme.

Value of Cacao in dollars per fanega.	Rate of Interest per cent.
Less than 10	Nil.
10 to 11	1
11 to 12	3
12 or more	5

It was estimated that the maximum amount outstanding at any one time would not exceed £120,000, and that the average amount on loan would be £50,000. Assuming that Government funds realise an average of five per cent. per annum the loss to General Revenue in interest on £50,000 would not exceed £2,500 (*see* Table XXI).

Table XXI.*

Showing Loss to Government in Interest by lending £50,000 to Cacao Planters instead of investing such amount at five per cent.

Value of Cacao in dollars per fanega.	Loss in £'s to Government.
Less than 10	2,500
10 to 11	2,000
11 to 12	1,000
12 or more	Nil.

* The Committee assumed that such Government funds would realise three per cent. per annum.

Provision was made for the repayment of outstanding advances over a period of years. This scheme contemplated a small loss of interest, certain administrative charges, and "negligible" losses of capital (12).

A Cocoa Industry Relief Ordinance embracing these proposals was passed by the Legislative Council in December, 1930 (13). In May, 1931, however, an amending Ordinance introduced important modifications. Section 5 of the Principal Ordinance, which detailed the purposes for which advances might be made, was repealed and replaced by the following :—"Advances may be made . . . for the maintenance and improvement of his (the cacao proprietor's) land, including the payment of labour and the purchase of supplies required to plant, cultivate and manure such land, and to reap and make merchantable the crop and produce thereof, and for no other purpose". This amendment was introduced with the object of withdrawing from applicants the right to apply for advances to meet interest on encumbrances, to pay rates and taxes, to repay moneys which had been applied to the maintenance and cultivation of the land during the period of one year immediately preceding the commencement of the Ordinance, or for such other purposes (excluding the personal expenses of an owner) as the Committee might deem necessary. The amending Ordinance further stipulated that "Advances to any owner during any one crop season (July to June) shall not exceed in the aggregate the estimated value of the crop to be reaped from the land based on the prevailing market rates".

The borrower is required to pay the entire revenue obtained from cacao into the Treasury. This is effected by arrangements whereby the planter markets his cacao with an approved merchant who remits the proceeds to the Treasury. This necessary and salutary proviso deprives the owner of the ability to borrow from other sources on the security of his property except under very onerous conditions. If the owner fails to pay his taxes as they fall due he is rendered liable to an additional charge of 10 per cent.* (56). Should the amount remain outstanding for a year the land may be declared forfeited to the Crown (55). In order to retain his property the owner must arrange to curtail his expenditure to such an extent as to secure a surplus at the end of the year. It is only within the past few weeks that current market quotations have exceeded $9.00 (£1 17*s.* 6*d.*) a bag. To reduce expenditure to less than $9.00 (£1 17*s.* 6*d.*) a bag implies a gross neglect of cultivation in most instances. On the other hand, to make advances sufficient to cover the cost of production, the payment of current and outstanding interest on encumbrances, and the repayment of moneys previously expended on maintenances and cultivation, would involve unduly high advances, and relieve mortgagees of the immediate incidence of the depression.

The existence of large numbers of mortgages, some of which exceed the capital value of the properties, makes it extremely difficult to devise measures of relief which will render effective assistance to the industry in general, and at the same time keep the risk to Government funds within reasonable compass. The mortgagee exerts pressure on the mortgagor for the payment of as large a portion of the interest as the property can reasonably be expected to pay. The mortgagee's ultimate interest would not be well served by insisting on payments which necessitated a gross neglect of the property, because the ability of the property to earn profits is the mortgagee's principal security. If the mortgagee is too lenient, his interests will be sacrificed for the benefit of other interested parties. If Government provides credit under conditions which individuals or other institutions consider wholly unfavourable it has the right to expect that its interests should not be allowed to suffer in competition with other claimants. This is provided for by the first charge on the cacao crop. Nevertheless, it would be detrimental to the general interests of Government to provide credit on a scale, and under conditions, which necessarily involved a neglect of cultivation, and of the control of witchbroom.

The writer is of the opinion that the present Cocoa Industry Relief Ordinance places undue emphasis upon the estimated value of the crop to be reaped from the land (13). Local quotations for cacao exhibit such marked variations that substantial modifications in the rate of advances may be required in order that loans in the aggregate may not exceed the value of the crop. Even if the price, as accepted by the Relief Committee, could be adjusted to the precise value realised, the total proceeds of the cacao might be appreciably less than those estimated, because of a deficit in the quantity reaped. The 1931/32 crop, for example, was one-third smaller than that of 1930/31 (14). It is, in fact, impossible to estimate the proceeds of a cacao property with precision. The drawback with the present regulations is that by regulating advances according to the price of cacao, circumstances may arise when quotations are so low that the loans may be insufficient to provide for the maintenance of the cultivation on a reasonable scale and the strict control of witchbroom.

The writer suggests that advances should be made at the rate of $11.00 (£2 5*s.* 10*d.*) a bag per annum. No advance should be made on any property where the cost of producing cacao exceeds $11.00 (£2 5*s.* 10*d.*) a bag, after taking into consideration the present lower rate of wages,

* Taxes which became due and payable on or before 31st March, 1931, were subject to an additional charge of 25 per cent. if they were not paid by the specified time (55).

stricter financial control, and a reasonable lowering of the standard of cultivation. Loans on such a scale would suffice for the maintenance of every efficient property. Loans should be made subject to the condition that an adequate amount is expended on the cultivation of the property, and the control of witchbroom. Assuming that $20.00 (£4 3*s.* 4*d.*) may be taken as the average normal expenditure per acre, a sum of $15.00 (£3 2*s.* 6*d.*) an acre might be accepted as a reasonable basis under existing conditions. If the property is heavily infected with witchbroom the minimum expenditure should be increased to $18.00 (£3 15*s.* 0*d.*) an acre, provided that assistance is obtained from other sources, as in the last intensive witchbroom campaign conducted by Government. Periodic inspections and the regular production of pay-sheets would be required to ensure that the cultivation is being maintained at the accepted standard.

Provided the expenditure per acre on the property is not lower than $15.00 (£3 2*s.* 6*d.*) (or $18.00 (£3 15*s.* 0*d.*), if heavily infected with witchbroom), but is less than $11.00 (£2 5*s.* 10*d.*) a bag the borrower should be entitled to apply the difference between the advances and the actual cost of production to the payment of interest on encumbrances, or such other charges as are normally borne by the property. By this means provision would be made in every case for maintaining the efficiency of the property, but the more efficient the property the greater the surplus available for meeting other charges. The property which produced an average crop at exactly $11.00 (£2 5*s.* 10*d.*) a bag, would obtain no advances for the purpose of meeting the claims of mortgagees or other interested parties. The current quotation for plantation cacao is $11.63 (£2 8*s.* 5½*d.*) a bag, so that with an average crop the entire advances would be repaid within the year and leave a small surplus at the disposal of the borrowers. In any year the amount outstanding would be limited to the difference between the advances at the rate of $11.00 (£2 5*s.* 10*d.*) a bag on the average crop, and the smaller revenue caused by a defect in yield or prices. It is unlikely that the deficit would ever be large, and the fact that the efficiency of the cultivation was being maintained would tend to ensure eventual repayment.

A rough estimate can be made of the amount necessary to provide advances on the above scale. The exports of cacao from the Colony during the past seven years have averaged about 55,000,000 lb., or 230,000 bags (8). To finance the entire industry at the rate of $11.00 (£2 5*s.* 10*d.*) for every bag of cacao would involve a total sum of $2,530,000 (£527,083 6*s.* 8*d.*). At least one-third of the area would be rejected as uneconomic, while probably another third is in the hands of individuals or companies who do not require relief measures. Provision could therefore be made for roughly one-third of the production with a sum of $843,000 (£175,625 0*s.* 0*d.*). There would be no need to have the entire amount available at any one time, but only that portion which represents the greatest excess of accumulated expenditure over revenue during the year. This fact may be illustrated by a simple example. Fig. VIII (*a*) represents the monthly distribution of expenditure expressed as a percentage of the total annual expenditure, while Fig. VIII (*b*) similarly represents the distribution of revenue. It will be noted that revenue shows greater monthly variations than expenditure. The monthly expenditure is never less than six per cent. nor more than eleven per cent., but the monthly revenue ranges from one to eighteen per cent. of the annual total. No less than seventy-two per cent. of the annual revenue is obtained during the five months January to May, and eighty-six per cent. during the seven months December to June. The period of greatest revenue is also the period of heaviest expenditure.

For purposes of illustration let it be assumed that advances are made at the rate of $11.00 (£2 5*s.* 10*d.*) a bag, that the price of cacao is also $11.00 (£2 5*s.* 10*d.*) a bag, and that the crop is an average one, *i.e.*, that expenditure and revenue are equal. Then, the greatest accumulated excess of expenditure over revenue amounts to 24 per cent. of the annual total, and occurs in the month of December. On this basis a sum of roughly $200,000 (£41,666 13*s.* 4*d.*), or 24 per cent. of the total advances of $843,000 (£175,625 0*s.* 0*d.*) for the year, would be sufficient to finance the producers of one-third of the industry, *i.e.*, that section in need of special relief and capable of offering sound security. One important qualification must be noted. The distribution of expenditure and revenue shown by Table XXII and Fig. VIII (*c*) represents the average results of one hundred properties over a period of seven years, and is not typical of each and every property or year. For example, a maximum sum considerably in excess of $200,000 (£41,666 13*s.* 4*d.*) would have been required during the season 1931/32 because, although a price of $11.03 (£2 5*s.* 11½*d.*) was obtained, the crop was exceptionally short and extremely late. On the other hand, a smaller maximum sum would be required for an early crop. In any event, the amount outstanding would never approach the maximum of $576,000 (£120,000 0*s.* 0*d.*) estimated by the Committee.

During the twelve months July 1931 to June 1932 applications were made for loans totalling $143,552 (£29,906 13*s.* 4*d.*), of which $116,134 (£24,194 11*s.* 8*d.*) was authorised, and $90,081 (£18,766 17*s.* 6*d.*) actually lent. By 30th June, 1932, $80,517 (£16,774 7*s.* 6*d.*) had been repaid, leaving $9,564 (£1,992 10*s.* 0*d.*) outstanding. The properties on which loans were made numbered seventy-eight, and had 9,089 acres under cacao, or only four per cent. of the total cacao acreage of Trinidad and Tobago. That so few planters

Table XXII.

Percentage Distribution of Average Expenditure and Revenue during each month on 100 Trinidad cacao properties, 1923-24 to 1929-30.*

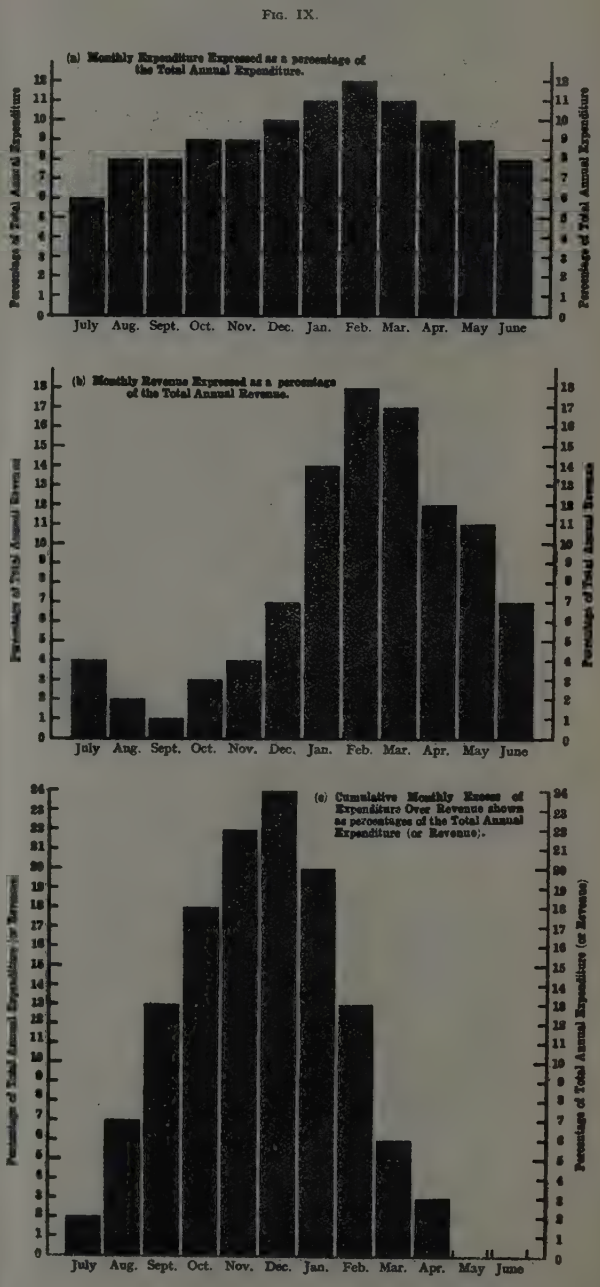
Month.	Monthly.		Cumulative.		Excess of Expenditure over Revenue.
	Exp.	Rev.	Exp.	Rev.	
July ..	6	4	6	4	2
August ..	7	2	13	6	7
September	7	1	20	7	13
October ..	8	3	28	10	18
November	8	4	36	14	22
December	9	7	45	21	25
January ..	10	14	55	35	20
February	11	18	66	53	13
March ..	10	17	76	70	6
April ..	9	12	85	82	3
May	8	11	93	93	0
June ..	7	7	100	100	0

applied for and obtained loans during a period acknowledged to be the most critical that the industry has experienced during the past hundred years, clearly indicates that the present regulations fail to cater for the great majority of the cacao planters in need of relief.

The history of the past twelve years presents a striking contrast with the previous fifty years. The price of cacao has frequently been below the average cost of production, instead of being almost invariably profitable. The planters have found it necessary to seek financial relief from Government, and no longer enjoy the generous credit facilities which were offered by individuals and companies seeking a profitable "gilt-edged" security. Yields are declining because large areas have passed their most productive age and the cultivation has been neglected. Formerly, yields increased as young areas approached their heaviest bearing age. Diseases and pests have caused increasing losses of crop and necessitated larger expenditure on methods of control. Witchbroom has added another serious burden to the harassed planter. Trinidad's cacao is no longer an important factor in the world market. Despite the fact that this Colony is the largest producer of "fine" cacao, her exports amount to only five per cent. of the world total. The complete elimination of her production would have but little effect on the world's supply. The quality of Trinidad cacao is too high to be included in the general formulae of most manufacturers, but is too low to compete on equal terms with such superior growths as Venezuela,

* This Table is compiled from 100 records representing properties of different ages, sizes, yields, and districts. The revenue included income from both cacao and all other sources. The cumulative excess of expenditure over revenue is based on the assumption that expenditure and revenue are equal.

FIG. VIII.—*Monthly (a) Expenditure (b) Revenue, and (c) Cumulative excess of Expenditure over Revenue on Trinidad Cacao Estates.**



* FIG. VIII (*c*) *is based on the assumption that the total Expenditure and Revenue are equal.*

Ecuador, and Ceylon. The cacao industry of Trinidad is now experiencing a painful contraction of area, and is no longer expanding at the rapid rate which characterised the previous half century. Pessimism and despair have replaced optimism and confidence.

Yet, the prospects are by no means hopeless. Prices have recently improved, and there is little doubt that further rises will eventually occur. The industry has a promising outlook provided the experiences and lessons of the past twelve years are studied carefully and applied to the problems of the future. The financial organisation of the industry must undergo drastic changes. Planters must adopt a long-term policy designed to maintain the efficiency of their properties. Scientific methods must replace the old rule-of-thumb routine. Fields which are no longer capable of earning profits must be eliminated. "Blanks" must be "supplied" and poor bearers replaced by the best type of planting material. The system of cultivation must be intensive instead of extensive. It is desirable that planters who retain cacao as the principal crop should endeavour to develop subsidiary sources of income. Above all, it is essential that every section of the property and every individual operation should be subjected to strict financial examination and control. The planter who fritters away his resources on the maintenance of unprofitable fields and trees, and who misdirects the energies of himself and his labour in the detailed day-to-day management of his property, is unlikely to derive much benefit from the discoveries of science. The responsibilities of the individual do not end in the field. Each planter and merchant can contribute something towards enhancing or depreciating the general reputation of Trinidad cacao. Just as excessive and "illegitimate" claying injured the good name of Trinidad cacao in the past, so careful preparation and grading may restore its credit in the future, and aid in maintaining the important premium which it enjoys over ordinary types of cacao. Though there is little scope in the future, as there has been in the past, for the individual whose principal activity is the reaping of cacao, there is room for the energetic business-like, public-spirited and scientifically-minded planter.

Table XXIII.

Prices of Trinidad Cacao at Store, Port-of-Spain.

Year.	Per Fanega.	Per Cwt.	Year.	Per Fanega.	Per Cwt.
	$ c.	£ s. d.		$ c.	£ s. d.
1874	8 25	1 15 0	1903	13 26	2 16 3
1875	10 25	2 3 6	1904	12 75	2 14 1
1876	13 00	2 15 2	1905	11 67	2 9 6
1877	13 25	2 16 3	1906	12 39	2 12 7
1878	16 75	3 11 1	1907	19 55	4 2 11
1879	18 00	3 16 4	1908	12 80	2 14 4
1880	14 25	3 0 5	1908-09	12 03	2 11 0
1881	13 50	2 17 3	1909-10	11 50	2 8 9
1882	14 00	2 19 5	1910-11	11 48	2 8 8
1883	16 70	3 10 10	1911-12	12 65	2 13 8
1884	14 60	3 1 11	1912-13	14 45	3 1 4
1885	15 75	3 6 10	1913-14	12 76	2 14 2
1886	15 70	3 6 7	1914-15	15 07	3 3 11
1887	14 75	3 2 7	1915-16	16 20	3 8 9
1888	13 50	2 17 3	1916-17	13 43	2 17 0
1889	12 50	2 13 0	1917-18	13 20	2 16 0
1890	12 63	2 13 7	1918-19	20 30	4 6 1
1891	13 13	2 15 8	1919-20	23 92	5 1 6
1892	13 25	2 16 3	1920-21	10 00	2 2 5
1893	14 50	3 1 6	1921-22	10 80	2 5 10
1894	12 75	2 14 1	1922-23	9 52	2 0 5
1895	12 23	2 11 11	1923-24	9 50	2 0 4
1896	10 41	2 4 2	1924-25	13 00	2 15 2
1897	10 34	2 3 10	1925-26	12 50	2 13 0
1898	15 79	3 7 0	1926-27	15 25	3 4 8
1899	14 44	3 1 3	1927-28	14 50	3 1 6
1900	15 20	3 4 6	1928-29	11 55	2 9 0
1901	14 38	3 1 0	1929-30	10 76	2 5 8
1902	13 33	2 16 7	1930-31	7 60	1 12 3

Table XXIV.

Exports of Cacao from Trinidad from 1797-1888.

Year.	Trinidad.	Year.	Trinidad.	Year.	Trinidad.
	lb.		lb.		
1797	96,000	1828	2,582,323	1859	4,758,350
1798	?	1829	2,756,603	1860	4,882,230
1799	258,390	1830	1,646,531	1861	8,472,302
1800	284,170	1831	1,888,852	1862	4,349,453
1801	324,720	1832	1,330,990	1863	7,014,337
1802	138,669	1833	3,090,526	1864	5,009,006
1803	361,070	1834	3,363,630	1865	6,611,160
1804	503,210	1835	2,744,643	1866	5,635,840
1805	527,690	1836	3,188,870	1867	7,641,960
1806	588,805	1837	2,507,483	1868	7,758,048
1807	355,000	1838	2,571,915	1869	6,269,920
1808	668,993	1839	2,914,061	1870	6,862,600
1809	719,230	1840	3,237,905	1871	6,447,380
1810	726,173	1841	3,122,220	1872	7,019,160
1811	640,732	1842	3,141,550	1873	7,695,520
1812	1,375,539	1843	2,803,295	1874	9,396,531
1813	1,029,512	1844	3,303,715	1875	6,272,540
1814	1,158,163	1845	2,528,482	1876	9,477,123
1815	1,065,808	1846	4,021,198	1877	9,726,742
1816	1,056,662	1847	3,738,376	1878	9,911,865
1817	1,341,461	1848	2,956,704	1879	11,641,170
1818	1,232,685	1849	4,728,185	1880	10,999,385
1819	1,506,445	1850	3,816,728	1881	10,809,796
1820	1,744,465	1851	5,008,920	1882	10,972,687
1821	1,214,093	1852	4,246,851	1883	11,649,785
1822	1,780,379	1853	4,842,875	1884	12,908,770
1823	2,424,703	1854	3,761,057	1885	13,729,565
1824	2,661,628	1855	5,427,351	1886	17,913,037
1825	2,760,603	1856	4,905,796	1887	11,927,067
1826	2,951,171	1857	4,690,166	1888	21,352,312
1827	3,696,144	1858	5,292,800		

Table XXV.

Exports of Cacao from Trinidad and Tobago from 1889-1931.

Year.	Trinidad and Tobago.	Year.	Trinidad and Tobago.	Year.	Trinidad and Tobago.
	lb.		lb.		lb.
1889	15,335,228	1904-5	40,753,776	1918	58,638,562
1890	21,552,593	1905-6	48,416,256	1919	60,743,283
1891	16,188,493	1906-7	27,570,928	1920	62,741,172
1892	25,041,635	1907-8	49,730,576	1921	75,238,566
1893	19,106,553	1908-9	49,137,088	1922	50,645,635
1894	21,608,384	1909	51,575,104	1923	67,692,265
1895	29,458,813	1910	57,858,640	1924	56,402,755
1896	23,481,848	1911	49,790,832	1925	49,476,609
1897	23,840,665	1912	41,525,627	1926	50,067,881
1898	24,340,960	1913	48,116,377	1927	51,934,857
1899	29,225,504	1914	63,447,876	1928	58,008,156
1900	30,383,808	1915	54,081,452	1929	61,888,740
1901-2	30,154,768	1916	53,692,052	1930	53,825,120
1902-3	37,585,184	1917	70,144,898	1931	57,186,512
1903-4	36,154,048				

Acknowledgments.

The writer wishes to record his indebtedness to the many individuals who assisted him in the preparation of Part V. He is especially obliged to the Chairman and Board of Management of the Agricultural Bank, and to the Honourable E. J. Wortley, Mr. S. M. Gilbert, Mr. Joseph Seheult and Mr. Frank Stell for their very generous co-operation.

Additional Literature.

(For previous references *see Tropical Agriculture*, Vol. IX, No. 8, August, 1932, pages 242-43, and No. 10, October, 1932, page 317.)

52. Board of Agriculture of Trinidad and Tobago, Meeting of—*Port-of-Spain Gazette* and *Trinidad Guardian*, 11th March, 1932.

53. Cocoa Export Tax Ordinance, No. 18 of 1932. *Government Printing Office*, Trinidad.

54. Gilbert, S. M.—Report on Special Witchbroom Control carried out in Turure and Tamana Wards, in May and June, 1932. Council Paper No. 76 of 1932. *Government Printing Office*, Trinidad.

55. Lands and Buildings Taxes Ordinance, Cap. 204, Laws of Trinidad and Tobago, Revised Edition, Vol. III. *Waterlow & Sons*, London, 1925.

56. Lands and Buildings Taxes (Amendment) Ordinance, No. 16 of 1932. *Government Printing Office*, Trinidad.

57. Plant Protection Ordinance, Cap. 138 and No. 10 of 1929. *Government Printing Office*, Trinidad.

58. Stahel, G.—Contribution to the Knowledge of Witchbroom Disease. *Tropical Agriculture*, Vol. IX, No. 6, Trinidad, 1932. Translation of Bulletin No. 39 of the Dept. of Agriculture, Surinam, 1919.)

59. Stell, F. — Mycologist's Report for 1930. *Government Printing Office*, Trinidad.

Table XXVI.

Year.	Cacao.	Sugar, Rum, & Molasses.	Exports.	Year.	Cacao.	Sugar, Rum, & Molasses.	Exports.
	Total value.	Total value.	Total value.		Total value.	Total value.	Total value.
	£	£	£		£	£	£
1865	147,329	500,924	820,109	1899	778,679	758,434	2,572,891
1866	165,416	647,595	1,031,682	1900	852,568	580,232	2,584,549
1867	188,613	673,624	1,106,122	1901-2	847,416	479,494	2,445,651
1868	167,445	676,440	1,116,198	1902-3	907,531	428,391	2,472,181
1869	132,032	978,366	1,391,232	1903-4	897,033	449,287	2,275,341
1870	162,149	755,822	1,277,574	1904-5	887,670	739,503	2,479,274
1871	172,873	996,068	1,497,337	1905-6	1,041,109	457,840	3,168,706
1872	193,614	863,657	1,439,905	1906-7	802,073	446,712	2,872,325
1873	212,717	1,027,175	1,733,615	1907-8	1,786,386	536,891	3,907,503
1874	213,077	721,733	1,412,261	1908-9	1,152,285	469,946	2,500,195
1875	231,822	888,135	1,625,082	1909	1,131,425	587,627	3,218,092
1876	227,856	710,187	1,636,619	1910	1,230,097	743,969	3,467,588
1877	275,960	976,893	2,151,250	1911	1,127,372	550,395	4,769,486
1878	304,081	788,380	1,839,068	1912	1,007,990	554,690	4,472,577
1879	424,609	879,067	2,264,745	1913	1,403,397	432,967	5,205,673
1880	302,358	904,950	2,185,512	1914	1,469,893	613,082	4,201,341
1881	266,661	735,165	2,099,101	1915	1,865,266	1,165,166	5,378,573
1882	316,733	951,769	2,452,033	1916	1,637,268	1,405,090	5,057,174
1883	372,629	960,277	2,686,670	1917	1,650,544	1,526,537	5,308,996
1884	380,878	701,866	2,769,727	1918	1,547,085	1,010,021	5,149,579
1885	385,901	737,317	2,246,664	1919	2,592,636	1,041,385	7,256,594
1886	521,278	594,846	2,509,140	1920	3,226,215	2,737,291	7,435,361
1887	354,420	860,089	1,870,612	1921	1,361,734	1,519,412	4,093,395
1888	611,876	775,413	2,132,761	1922	1,196,166	1,158,630	3,706,618
1889	411,243	925,897	2,308,832	1923	1,286,494	1,121,364	4,298,378
1890	531,025	695,702	2,179,432	1924	1,165,816	1,276,850	4,521,225
1891	439,786	700,003	2,058,761	1925	1,257,255	1,127,459	4,677,148
1892	648,103	733,323	2,258,063	1926	1,270,335	1,028,493	5,006,955
1893	535,055	802,904	2,320,824	1927	1,671,883	784,992	5,588,091
1894	509,808	644,241	2,000,748	1928	1,651,179	1,230,547	6,184,464
1895	620,634	649,421	2,065,104	1929	1,446,127	1,081,729	6,539,343
1896	452,141	742,564	2,165,820	1930	1,136,056	801,718	5,372,423
1897	532,123	560,179	1,994,926	1931	826,333	934,633	4,170,594
1898	705,956	623,924	2,310,133				

STUDIES IN TROPICAL LAND TENURE.

By H. Martin Leake, sc.d.

(4) East Africa.

East Africa offers an example of a phase of development very different from those hitherto considered. The impelling causes behind this development were by no means simple; but if the same primary cause, international competition, lies at the root of the race for the partition of Africa, the similarity ends here. That partition, which took place towards the end of last century, was accomplished with little, or none, of that active military rivalry so characteristic of earlier colonial development. Humanitarian motives, pre-eminently the suppression of the slave trade, played a not unimportant rôle. It is true that European contact was established with the East Coast at an early date but the glamour of India and the East proved to have the greater appeal and a powerful Arab influence had to be faced. The Portuguese alone established a somewhat precarious status, for long undisputed by other European powers. British influence, exercised from India, dates from the early nineteenth century and, by the middle of that century, this influence became dominant in Zanzibar. About the same time, knowledge of the interior began to accumulate through the work of missionaries and explorers and, with the opening of the Suez Canal (1869) the time was ripe for a sustained interest in the East Coast. An initial rivalry between British and German interests was settled by the International Agreement of 1886 which defined accurately the boundaries of the spheres of influence with regard to the Sultan of Zanzibar's possessions, including the coastal islands and a coastal belt ten miles deep, but less clearly defined the interior boundaries. In 1888 the Imperial British East Africa Company received a Royal Charter under which it was empowered to enter into treaties within this British sphere. Owing, however, to the vagueness of the interior delimitations, openings remained for international rivalry and, in consequence, the Company was compelled immediately to extend its sphere of activities to Uganda. Though this rivalry terminated with the Anglo-German agreement of 1890, financial troubles supervened and, in 1895, the Charter was relinquished and the East African Protectorate was established under the administrative charge of the Foreign Office. In 1905 the Protectorate was placed under the Colonial Office and, in 1920, the name was changed to Kenya Colony and Protectorate, the latter name applying to Zanzibar and Pemba.

Meanwhile the hinterland was being opened up by a railway, commenced in 1895 and completed to the Victoria Nyanza in 1901. Largely constructed for the reason that modern transport would abolish the safari (porter) system and so strike the shrewdest blow at the slave trade, it led to far reaching consequences, for it threw open the interior to European settlement for which the climate was eminently suitable. For such settlement the highlands of Kenya between the coast and the lakes proved most attractive and here the earliest settlements took place. At this period the idea of the trust for the native races had not received the prominence now attached to it and the trust for civilization held the field. Consequently interest centres in the first instance on the terms under which land was offered for colonization.

Kenya.

Physiographically Kenya consists of three belts running roughly north and south. A narrow coastal belt, hot and humid, passes into the Nikya, a broad, bush-covered desert which, in turn, is succeeded by the highlands, traversed by a series of valleys of which the Rift Valley is the most important. It is this latter belt which has proved so suitable for European settlement and to which attention was first directed. The tract is relatively thinly populated and the population sharply divided into pastoral tribes, among which the Masai dominate, and agricultural tribes like the Kikuyu and the Kavirondo. Cwirg to this paucity of population land was available in abundance and, even before the railway was opened, a demand for land arose which could be satisfied without raising questions of encroachment on native claims. Such demand was met by the Company and, as early as 1891, a proclamation was issued forbidding all dealings in land between Europeans and natives. In 1894 Regulations were issued under which grazing and agricultural leases were obtainable, the validity of which was only recognized if they were registered. Three classes of lease were established, grazing leases for not more than 20,000 acres, agricultural leases for not more than 2,000 acres, both leases renewable for 21 years, and homestead leases for not more than 160 acres, subject to certain conditions anent development and convertible into fee simple holdings after five years. In 1897 the Foreign Office issued new Regulations retaining the period of lease at 21 years, but in 1898, a 99 year lease was introduced. In 1902 again new Regulations were introduced which permitted both purchase and lease of land. Agricultural and pastoral lands were limited to 1,000 acres with a freehold price of two shillings an acre while leases were for 99 years. Homesteads of 160 acres, with the development clauses retained, were purchasable but with a 3-year pre-emption on a further 480 acres.

It is noteworthy that, in these early Regulations, the Company appears to have assumed the right to the disposal of the land, a fact due to the paucity of the native population in those areas which had proved most attractive to the European settler, a paucity in large measure due to the weakening of the Masai through epidemic disease as well as through loss of their cattle from rinderpest in 1890. It was at this period, too, that the

Chamberlain view of the position of the home country as trustee for civilization was predominant and European settlement was being actively fostered. Under the combined stimulus of these ideas and of the opening up of the country by rail, European immigration advanced rapidly and the question of native rights in land could not long be kept in abeyance. In the Annual Report for 1904 (1) reference is made to the delay in colonization arising from the lack of settlement of the native question and in 1904 the question was set at rest with regard to the area most favoured for settlement, and for the time being, by the delimitation of the Masai Reserve. From this time onwards the land question develops along two collateral, but independent lines, that of alien settlement and that of the indigenous population. For many years the former interest dominated and this may be dealt with first.

It is not possible to follow in detail the successive phases of this land question. They are complicated and the discussions are marked by a good deal of heat. The earlier years of this period are characterised by the grant of large tracts, notably one of 320,000 acres to the East African Syndicate, to development companies many of which were concerned with the growing fibre industry. In 1904 a Land Committee was appointed which reported the following year and, shortly after, a Land Board was established. The friction which the discussions of this period indicated to have existed, is traceable to two causes; inadequacy of the arrangements with regard to grants, particularly in the matter of survey and, more fundamental, the question of the disposal of the incremental value of the land which was becoming a matter of some moment with the increasing number of settlers. About 1908 the question of the revision of the terms under which land would be granted began to be considered and a new Crown Lands Ordinance in supercession of that of 1902 was drafted, but it was not till 1915 that the question was finally settled by the passage of the Crown Lands Ordinance (Ord. XII of 1915). As early as 1908 the Secretary of State, in his despatch to the Governor (despatch, dated 19th March, 1908) wrote that "Steps must be taken to prevent the accumulation of enormous quantities of land in the hands of individuals through the operation of free transfer and also that the conditions of tenure must be such that the Government may be able from time to time to obtain its share of the unearned increment in the value of the land". Accusations were freely made, and continued to be made, that resort was being had to the process of 'dummying' to circumvent the limitations on accumulation (2). On the other hand, the settlers desired a form of tenure which would render their land an easily realizable asset and a form of property on which money could readily be raised on mortgage; from their point of view the question was one of ways and means to securing working capital.

In 1907 grazing leases had been reduced from 99 years to 21 years subject to a further extension of 21 years at the prevailing rate of rent. This drastic change aroused intense opposition (3) and, in 1908, the 99-year lease without revision of rent was reintroduced pending final legislation. In 1911 the terms were revised leaving the lease at 99 years but with revision of rent at the 33rd and 66th years. Towards the end of that year the allotment of land was discontinued since the method adopted was proving unsatisfactory and, in the following year, a system of auction was adopted with payment of purchase price spread over ten years, the land having been surveyed and divided into farms prior to auction.

In 1915 the thorny question was settled by the passage of the Crown Lands Ordinance already noted. This was a general Ordinance which defined Crown Lands as including all lands occupied by native tribes and all lands reserved for the use of any native tribe. Under it the Governor was given wide powers to grant by lease or otherwise alienate land and to accept the surrender of earlier leases, issuing new ones under the Ordinance. It established a post of Commissioner of Lands with Land Rangers whose function was to survey and divide up lands into farms which, if over 5,000 acres, required the consent of the Governor and, if over 7,500 acres, the consent of the Secretary of State. Leasing was by auction with an upset price and notification was made whether other than Europeans might bid. New leases were for 999 years with revision of rent every 30 years and, in that revision, no improvements were to be taken into account. Implicit in the lease were certain conditions regarding development and subsequent maintenance. Subdivision was only permitted with the sanction of the Commissioner of Lands when new leases were to be issued. The Ordinance further established a Crown Lands Registration Office and made compulsory the registration of all transactions in land whether sale, mortgage, assignment, lease or subdivision and gave the Governor in Council power to veto. A further section of the Ordinance deals with lands reserved for native tribes and will be referred to later.

All land is now granted leasehold on a revisable 999 year lease, the only freeholds being those granted under the Crown Lands Ordinance of 1902 and a few grants, not exceeding 300 acres, under the Discharged Soldiers Settlement Ordinance of 1921. The practical effect of this Crown Lands Ordinance has been to distribute the land in the colonized area into a number of units, moderate in size and independent; and any official stimulus to co-operation between these appears to be lacking. It has had the further effect of stereotyping the development of the Colony along the two collateral and independent lines of production by native, and by European agency. This development has raised certain subsidiary problems, notably that of labour required by the European colonist. The problem of labour on the farms had long been a difficult one and it was intensified by the

demarcation of the reserves. The problem was met by the passing of the Native Squatters Ordinance (Ord. 33 of 1918) which permitted settlement outside the reserve only by permit to the head of a family. The terms under which an 'occupier' was allowed to permit native settlement on his land were stringently laid down. Among other conditions, the Ordinance laid down that "no occupier shall enter into any contract with the head of a family or other native whereby the occupier shares any profit derived by such head of a family or other native from his cultivation on the farm or from the increase of his stock on the farm". The rates of pay must be agreed on before a magistrate and the agreement must include details as to the period of residence, the supply of materials for huts and of land for cattle grazing, and a guarantee of 180 days work. The magistrate is, further, empowered to return any native to his reserve unless in possession of a permit. The whole tenor of the Ordinance only emphasizes the demarcation of the two areas, for native settlement is only permitted temporarily in the colonized area to the extent that the demand for a labour force necessitates. More recently doubts have arisen as to whether the terms are such as to satisfy fully the labour demand and the question is reviewed in the Report of the Labour Commission (1927).

A further complication of the Kenya land problem arose from the fact that, opened up as the country was under the wing of the home country, the actual process was largely effected by Indian labour. The Indian, equally with the European, found the country to his liking and stayed. To the Indian, the section of the Crown Lands Ordinance of 1915, limiting the bidding for land in the highlands to Europeans unless otherwise stated, appeared unjust and, further, it was claimed that the Governor's power of veto was not limited to the original sale but extended in practice to cover subsequent transfers. As the result of investigation, lands were set aside in the lowlands in which a similar restriction, but in favour of Indians, was imposed (4). Land is here held under the terms of the Crown Lands Ordinance of 1915.

Meanwhile the question of the rights of natives to land was becoming prominent. With the increasing influx of Europeans and the extending area of their settlement, a growing sense of insecurity was arising among the native tribes. The first adumbration of this problem can be traced to an early date when, as already stated, in 1891 transactions in land between Europeans and natives were prohibited. Under the Crown Lands Ordinance of 1902 land in actual occupation of natives was not allowed to be sold or leased but any occupied land within a leased area would, on ceasing to be occupied, pass to the lessee and the native owner's tenure was, in consequence, precarious. By 1904 the problem had become urgent and in that year the Masai Reserve was demarcated, thus initiating as a definite policy the separation of the two landed communities. Further demarcations followed and, by 1925, some 52 Reserves had been demarcated (5).

But this demarcation of Reserves failed to allay native doubts. The original Masai Reserve consisted of two areas lying respectively to the north and south of the railway and was based on a treaty entered into with the Masai leaders. In 1911 a further treaty was arranged by which the northern area was evacuated, a treaty not unanimously accepted by the Masai concerned but upheld on appeal to the courts on grounds which only added to the feeling of insecurity. An account of the Masai question has been given by Stanford (6).

The Kikuyu offer a different aspect of the same problem. The Masai were a pastoral tribe and, as such, had built up no well defined tribal system of land tenure. The Kikuyu, on the other hand, were definitely an agricultural tribe which had evolved a complex code of tenure. They had settled in modern times in a heavily forested country and they had acquired their footing in the country by purchase from the former occupants, the hunting tribe known as the Dorobo. Large areas of forest were cleared by their energy and these constituted some of the richest land in the country. As such, it offered attractions to the settlers and, under the prevailing custom, land was alienated which was not under actual cultivation. Here, again, a ruling of the high court, based on the Crown Lands Ordinance of 1915, appeared to extinguish, or at least render very precarious, the Kikuyu title. According to one judgment, the natives became tenants at will of the Crown.

The case of the Kikuyu assumes its importance because it constituted the most advanced tribe of the country; but, in lesser degree, the same uncertainty attached to all tribal lands and gave rise to an amount of unrest which forced the question to the fore. In 1926 an amendment to the Crown Lands Ordinance of 1915 was passed (Ord. XXII of 1926) which empowered the Governor to declare by Gazette notification lands as Native Reserves; all lands so notified as declared, to be reserved for the benefit of the native tribes, but such reservation did not confer the right to alienate. Further, no land in a Native Reserve was to be sold, leased or otherwise disposed of except for purposes beneficial to the inhabitants of the reserve. In the same year some 42 Reserves, including the Masai and Kikuyu Reserves, were duly notified and their detailed boundaries tabulated in the Gazette. The security thus given went far to allay the feeling of insecurity and in 1928 it is noted that "satisfied on this point" (the guarantees of reserves) "the tribes, particularly the Kikuyu, are now turning their attention to the rights of individuals to holdings in the Reserves" (7).

There can be little doubt that the trouble which developed, particularly in the case of the Kikuyu, arose through failure in the early days to study native custom in regard to

land. Had this been done, it would have been recognized that a claim to ownership was not coincident with cultivation; that, with the Kikuyu particularly, a system of rotating the cultivated area and allowing land to revert to bush, after the chena system of the East, was in practice. It was wrongly assumed that uncultivated land, or even unoccupied land, was without owner and, therefore, the unencumbered property of the Crown.

Even when the policy of reserves was first initiated, no formal attempt was made at internal administration and the question of individual rights in land was left to be determined by the tribal leaders. This aloofness of the Administration from the internal organization of the tribes was one which could not continue for long as, involved with the question of land tenure, is that further question of the adequacy of the area set aside to meet growing needs. With the security now offered, an expansion of the population is to be expected and the pressure on the land which such expansion creates in a limited area, demands an ever clearer definition of personal rights. An early study of tribal customs and rights with regard to land had been made by Beech in the case of the Kikuyu (8) and, with the recent recognition of the importance of such a study, official investigation has followed in the case of the Kikuyu (9) and of the North Kavirondo (10) tribes. This need for some regularization of the internal administration with regard to land in the reserves has received further general recognition in the Native Land Trust Ordinance (Ord. IX of 1930) which created a Central Board, composed of the Governor, Chief Secretary, Attorney-General, Chief Native Commissioner, Commissioner of Lands, Senior Commissioner and four unofficial members, working through the Local Advisory Board, composed of the Political Commissioner, Deputy Commissioner, one European and one African unofficial member. The function of the Board is defined as the granting of leases; these must not exceed 33 years and the Local Native Council must be consulted. No power to alienate is granted and rents and other fees are payable to the Local Native Fund. Conditions are also laid down governing the terms of licences to non-members of the tribe to graze, remove timber and forest produce as well as sand and lime.

There are a few further points attaching to the indigenous Kikuyu system which are pertinent to the subject. As a general rule, land is not, under it, alienable by outright sale but this does not apply to the Kiambu District where such sale is recognised. Tenancy as the word is commonly understood, is unknown but cultivation rights on Ithaka (plural of Githaka) of other sections of the tribe are obtainable by various means; the nearest approach to true tenancy being acquisition of such cultivation rights in return for some form of property, usually stock. Such rights, however, when granted, are always redeemable and, when stock has been given, custom dictates the number of head to be returned. Subdivision is checked by removal and fresh purchase from the Doroba; but, with a restricted area such as is now arising, the mode of inheritance leads to subdivision and already the question of the uneconomic holding has arisen in practical form.

The Githaka system is an indigenous system evolved in a tribe which has developed an agricultural bias. That it is not a static system, even when undisturbed by external influences, but one in the process of evolution, is evident. That development, as far as it is due to an internal stimulus, is, however, only carried so far as to satisfy the local demand for agricultural produce. The same conditions apply with regard to other reserves with a force greater or less according to the extent to which an agricultural mode of life has been developed. The tribes must be considered as self-contained economic units; the forces leading to the evolution of the land system being restriction of area and increase of population. In recent years these indigenous systems have been subjected to other influences, not the least of which is the tendency to the breakdown of that self-sufficiency. The progress which contact with the outer world makes inevitable, is creating desires which can only be met by production of an exportable surplus, and interest centres on the manner in which that surplus is to be obtained. Here it is noteworthy that neither of the two reports on the tenure systems deal with this aspect, though the former (the Kikuyu Report) devotes a section to the consideration of "the difficulties which arise in reconciling the Githaka system with developments which are necessary for the advancement of the Reserve" and includes under that section the question of training centres. It is somewhat surprising that, though the Committee rightly recognized the system is not a static one and the need for directing the evolutionary process along lines which will adapt it to modern conditions, it did not consider the adaptation of the tenure system to a mode of production which must form the basis of that trade, namely agricultural production for export; for this is the fundamental problem. Trade cannot develop without production for exchange.

It is necessary, therefore, to search elsewhere for the direction in which the stimulus to production for export is being sought. That is to be found in the White Paper on Native Policy in East Africa (11). It is a policy of permitting the natives "subject to any necessary safeguards . . . to grow such crops and to keep such stock as they think most profitable" and "of encouraging actively the production of such crops and the raising of such stock as the native may prove best fitted in the particular circumstances to undertake and such as will give him the best return for his efforts". Further, adequate access to

markets is to be given him and care is to be taken that he receives a fair price for his produce. The agency which is to direct this development is governmental. These, however, are generalizations, the practical application of which can be illustrated in Kenya.

In 1926 was passed the first Ordinance developing this policy for organizing production for export, the Crop Production and Livestock Ordinance (Ord. III of 1926). It confers on the Governor extensive powers to make rules for improving the cultural conditions and quality of the crop. Also under the rules, it may be specified what may, and what may not, be grown; a diseased crop may be destroyed with, or without compensation; any crop or produce may be inspected while in transport; preparation and marketing may be controlled. With regard to livestock, rules may define and limit the number, kinds, ages and sexes of livestock carried in any area and may aim at the promotion of the improvement of quality of the livestock and the prevention of disease. Under this Ordinance several rules have been promulgated. In 1928 rules were issued applicable to the Ulu Province (Government Notice No. 242) which render it unlawful to keep.

(1) a bull over 15 months unless approved for breeding purposes,

(2) an ox in the opinion of the Inspector over five years unless required for draft,

(3) a cow which has not produced a calf within two years,

(4) a cow in the opinion of the Inspector unfit for breeding,

(5) an animal of any age suffering from incurable disease or injury.

The same rules make inoculation against rinderpest compulsory. Though these rules are qualified by a statement that it is the intention of Government only to apply them gradually and that the process of reducing the number of uneconomic stock is expected to extend over several years, they are drastic rules and it is difficult to see how they can be reconciled with the generalization of the White Paper that the native shall be allowed to keep such stock as they think most profitable.

On the crop side, in 1929 (Govt. Notice No. 517) the sale of Ground Nuts in the Nyanza Province before a date fixed by the Director of Agriculture is prohibited and rules are laid down with regard to ripeness of, and dampness in, the product. In 1930 (Govt. Notice No. 378) rules, applicable to the whole of Kenya and not merely to any Reserve, prohibit the cultivation of any wattle other than *Acacia dealbeata* or *A. mollissima* while sale of seed is prohibited except under licence from the Director of Agriculture issued only after inspection. On the marketing side, rules have been issued with reference to maize and simsim which apply to the Nyanza Province, and with reference to wattle with application to the whole Colony. Kenya, thus, illustrates the direction in which the organization of native production for export is being sought. Antedating, as the Ordinance does, the White Paper defining the policy, it must be assumed that the latter is merely the interpretation of an accepted policy, already adopted in practice. It is a method of development which leaves aside the units of production and concentrates on governmental regulation and supervision.

REFERENCES.

1. Accts. and Papers, 1905, LVI, p. 179.
2. Cmd. 2629; Accts. and Papers, 1926, XXII, p. 23.
3. Cmd. 4117; Accts. and Papers, 1908, LXXI, p. 1039.
4. Cmd. 1922; Accts. and Papers, 1923, XVIII, p. 141.
5. Cmd. 2387; Accts. and Papers, 1925, IX, p. 855.
6. Sandford, G. R. 1919. An Administrative and Political History of the Masai Reserve.
7. Ann. Admin. Report, 1928.
8. Beech, M. H. Kikuyu System of Land Tenure. *Journ. of the African Soc.*, XVII, pp. 46-136.
9. Report of the Committee on Native Land Tenure in Kikuyu Province, 1929.
10. Report of the Committee on Native Land Tenure in the North Kavirondo Province, 1930.
11. Cmd. 3573, 1930.

OBSERVATIONS CONCERNING THE HEALTHINESS OF COFFEE TREES IN COSTA RICA.

By Dr. Oskar F. Kaden, San Thome.

The conditions for growing Arabica coffee in Costa Rica are ideal: it is grown on deep volcanic soils at an altitude varying from 2,000 to 5,000 feet above sea level; the annual rainfall is 80 to 120 inches, and the average temperature, 20°C. In addition, labour and transport in Costa Rica are very cheap. Costa Rican coffee commands a very good price, and most planters are obtaining 15 per cent. profit, whilst some exceptionally good plantations show a return of 30 per cent. profit.

These favourable conditions are reflected in the general excellent state of the plantations, as expenditure on maintenance and improvements does not have to be controlled as carefully as in other coffee-growing countries. The diseases and pests known by planters in Costa Rica have spread very little. Some plantations actually give the impression that they have been overtreated, particularly as regards soil treatment (clean weeding).

Parasitic Diseases.

In the month of May, which is the end of the dry season, the following pests and diseases were in evidence :—

Coccids :—*Pseudococcus citri*, *Coccus sp.*, *Saissetia hemisphaerica* ;
Mites :—*Epitetranycnus althea* ;
Fungi :—*Cercospora coffeicola* (mancha), 233
Umphalea flavida, and *Rosellinia* spec. (maya).

The coccids, the mite and *Cercospora coffeicola* are parasites of debility. The planters are combating the coccids with lime mixture. Emulsions of petroleum or creoline are as yet not used. The moistness of the soil is in many instances the cause of infection, and proper drainage may be a better remedy than spraying. To control the mite, sulphur dust is used, and against *Cercospora*, shading and manuring have proved very helpful. *Rosellinia*, a kind of collar crack, must be watched carefully. As a rule, *Erythrina costaricensis* (poro blanco), and *Erythrina corallodendron* (poro poro), which are the chief trees used for shading purposes, are the disease carriers.

Umphalea flavida is not as dangerous as generally described in literature. Its character is not by any means comparable with the really dangerous leaf-fall disease, *Hemileia vastatrix*. Wherever *Umphalea* is attacking the coffee-trees, the trees are either growing in places that are too damp, or the trees are planted too closely together and badly pruned. Very often they are also over-shaded, or the plantations are akin to forest. Contrasted with *Cercospora*, *Umphalea* is a pure parasite attacking the healthiest plants, but its prevention and control is easy, and consists merely in pruning out or thinning out coffee, shade and forest trees, as well as sometimes in draining. *Hemileia vastatrix*, *Stephanoderes hampei* and *Heterodera vastatrix* do not exist on coffee in Costa Rica.

The foregoing remarks refer to pests and diseases. The following section refers to a non-parasitic disease, which is widely spread over most coffee plantations in Costa Rica.

Wilt Disease of Coffee.

The author was surprised to notice in Costa Rica (particularly in the oldest cultivated districts, namely, San Jose and Tres Rios), a non-parasitic disease, similar to one which he identified last year in coffee estates in Angola (Portuguese West Africa).

The branches of coffee trees attacked by the wilt disease dry out, causing shedding of leaves and sometimes death. The time when this occurs, and the extent of the disease, depend on the course of the dry season. Effects may show in a few days. Further details concerning the incidence of the disease in Costa Rica cannot now be given, since the author has seen the disease only in its last stages. Nevertheless, it was sufficiently evident that coffee trees showing wilt disease lacked some environmental factor, probably induced by unsuitable soil treatment or by exposure, or that some of the attacked plantations had been extended beyond the limits of good coffee soils. The manner of pruning the trees also seems to have exerted adverse effects.

Affected coffee trees appear to suffer from great variations in humidity of air and soil, as well as evident interruption of nourishment at their critical growth period during the dry season. Rainfall and distribution of rain over the year cannot be the cause, as wilt disease appeared only recently.

The above explanation is confirmed by evidence appertaining to another wilt disease of coffee, namely :—

Early Ripeness (*la Chasparea*).

Ripening of coffee berries formerly occurred only at the end of the dry season, but during recent years the onset of ripening frequently took place at the beginning. The causes of this phenomenon appear to be the same as those described under Wilt Disease.

Advice on the Control of Coffee Wilt Diseases in Costa Rica.

To prevent and control non-parasitic diseases in Costa Rica it will be necessary to consider the possibility of seriously modifying the practices of coffee cultivation in such a way that the environment of the attacked trees will be improved. A better selection of soils for plantations, and the introduction of means of stabilising humidity, such as the provision of more windbreaks and shade trees, together with soil treatments such as will increase the formation of humus, may be necessary.

The present soil treatment in Costa Rica consists chiefly in clean weeding by means of shovels. This practice produces furrows and mounds, and destroys humus, drying up the soil, and depleting it of soluble ingredients.

Hoeing, together with manuring with cattle manure or composts of green manure, is the best way to improve the soil. It should be easy in Costa Rica to obtain sufficient stable manure, as large pastures are available between plantations. The climate is quite suitable for cattle. To make a compost similar to the cattle manure, the "Adco" process may be used. To obtain green manure, the planting of leguminous crops like the Crotolarias and Tephrosias in open spaces in the plantations is recommended. For pruning, the new Costa Rican method, developed by Sr. Don Bernardo Yglesias, Director of the School of Agriculture in San Jose, is recommended. This method has been already applied successfully in some coffee plantations.

The author wishes to take advantage of this opportunity of expressing appreciation of the many courtesies extended to him during his visit to Costa Rica, particularly to Mr. Pierre Lange, and to Mr. Crawford of the United Fruit Company.

MANURING BANANAS.

By R. C. Wood, M.A., Dip. Agric.
(*Professor of Agriculture, Imperial College of Tropical Agriculture.*)

The commercial production of bananas well illustrates two extremes of agricultural practice, for bananas may be grown under very intensive, as well as under very extensive conditions. As an illustration of the first, may be quoted the system of cultivation adopted in the Canary Islands, where the land is terraced, irrigated and very heavily manured, and is in consequence highly capitalised—rents may run as high as £150 an acre (1).

At the other end of the scale, we find the cultivation in the Caribbean areas described by Wardlaw (2), where "the native fertility of the soil is utilised with the minimum of treatment. When soil deterioration or the incidence of disease reduces the crop to a certain point, the plantation is abandoned and new land is opened up".

Between these two extremes, will be found the most profitable treatment for this crop in Trinidad, if it is ever to take its place among the exports from the Island, and it is the purpose of this note to indicate the need for manuring, which in most cases, will certainly arise.

Two small experimental plantations of *Gros Michel* and *Lacatan* respectively were put down on the College Estate at the end of 1929, on a strip of land bordering a hill stream, which was thought at the time to possess rather more than the average fertility of this class of land. Both varieties started well, but the *Gros Michel* was attacked by Panama Disease when about ten months old (November, 1930), and was eventually removed and replaced with the *Governor* variety (*M. Cavendishii*). The *Lacatan* at the same time began to look unthrifty, and it was soon abundantly clear that it was going to yield no crop. The leaves yellowed prematurely and the trees gave way as soon as a bunch started to form. Accordingly this was also removed, and in May, 1931, the plot also was replanted with *Governor*. These were no more successful. They did not suffer from Panama Disease, like the *Gros Michel*, but they showed similar symptoms to the *Lacatan*, and in a few months it became clear that the trouble was not that *Lacatan* was weak and lacked constitution, but that there was something wrong with the general environment. Manuring suggested itself, and in March, 1932, two lots of trees were manured as follows:—

Lot 1. 54 Trees.
Each tree received 200 lb. synthetic pen manure, and 1 lb. of Muriate of Potash.

Lot 2. 119 Trees.
The same, but without Potash.

This dressing of manure was at the rate of 38 tons per acre, as the stools are planted 10 feet apart each way: the potash was at 435 lb. per acre.

The effect has been remarkable, as will be seen from the photographs, which show (Fig. 1) the trees receiving pen manure and potash, and (Fig. 2), those receiving pen manure only. All leaf discolouration has disappeared, and the bunches now forming are fully up to standard.

That this improvement is due to the manure is of course evident, but it has largely acted in an indirect and rather interesting method. The stunted trees shown in (Fig. 2) were found on examination to be suffering severely from the attack of a *Tomarus** beetle, which had burrowed into the bulb (Fig. 3) and in bad cases had almost completely destroyed it (Fig. 4). Signs of beetle attack were also found in the manured trees, but the plants were apparently so vigorous that the attack was without effect.

Whether the beetle finds the poor stunted plants more palatable or whether it is a case of the vigorous plants making light of the attack, cannot be said, but from the practical point of view, it is clear that the application of manure has made the difference between what seems the prospect of a fair crop, and—not a poor crop, but *no crop at all.* Whether manuring on any scale will pay for itself or not is again another matter, and data are being collected to afford information on this point. Meanwhile careful experiments are being laid out to ascertain the exact value of potash to the banana crop on these soils. It may quite probably have considerable influence on the *production* of fruit, and further, as in the case of some other fruits, it may have a favourable effect on the keeping quality of bunches intended for shipment.

Acknowledgment.

The four photographs which illustrate this article were kindly taken by Mr. A. K. Briant, of the Staff of the Mycology section of the College, to whom my thanks are due.

References.

(1) *Tropical Agriculture*, Vol. VII, No. 12, p. 320.
(2) *Tropical Agriculture*, Vol. VI, No. 9, p. 243.

TEOSINTE.

The *Journal of Heredity* (Vol. 23, No. 7) has recently reported the rediscovery in Guatemala of teosinte, *Euchlaena mexicana* Schrad., a plant which has attracted special interest as the nearest wild relative of cultivated maize. Teosinte was first reported in Guatemala in 1869 but has not been found there since that time. Early this year, however, it was rediscovered in the Rio de Paz, about 133 Kilometres from Guatemala city at an altitude of about 3,300 feet. The plant was found mostly in old corn fields, ranging cattle apparently having prevented its distribution in unfenced ground. Teosinte is to-day rather widely distributed about the world and while it has some value as a forage crop it has never been grown to any extent for that purpose.

*See "Insect Pests of the Lesser Antilles" by H. A. Ballou, where *Tomarus bituberculatus*, Beaud., is named as the pest.

MANURING BANANAS.

FIG. 1.—*Contrasting the stools which received 200 lb. synthethic manure and 1 lb. muriate of potash, with those on the left which were not manured. (Taken four months after application). The thick cover crop of "Dolichos hosei" may be noted.*

FIG. 2.—*As above, but the trees on the left have received only synthetic pen manure. The miserable appearance of the unmanured trees is well shown. A cover crop has not yet been established here.*

FIG. 4.—*Severe attack of "Pomarus" beetle on banana. The whole of the base of the "bulb" has been eaten away.*

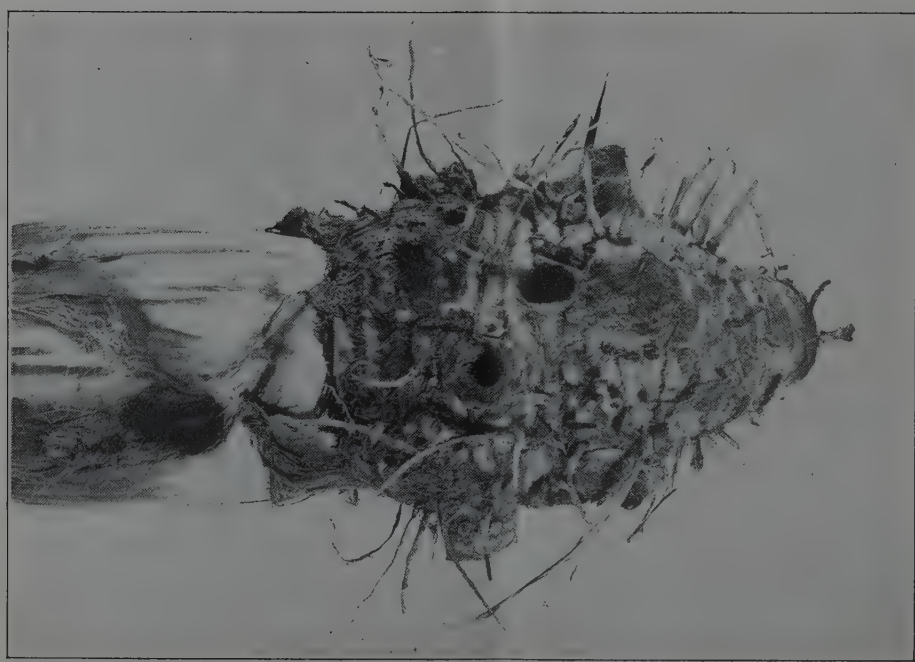


FIG. 3.—*Showing attack of "Pomarus" beetle on banana "bulb."*

REVIEWS.

INTRODUCTION TO AGRICULTURAL BIOCHEMISTRY.

By R. A. Dutcher and D. E. Haley. *John Wiley & Sons*, New York, or *Chapman & Hall*, London, 1932; pp. 484, price 28*s*.

This textbook is an ambitious attempt to survey the whole domain of agricultural chemistry. It is divided into three parts; the first deals with general matters, such as the history of agricultural chemistry, the classification of the chief chemical compounds that occur in plants and animals, and the physical states of matter. The second part deals with the plant, and includes chapters on seed germination, the chemistry of the soil and the atmosphere, manures and insecticides, the absorption and assimilation processes of the plant, the synthesis of carbohydrates, proteins and fats, and plant respiration. The last part deals with the animal, under the headings; foods, their nature and digestion; body tissues, their kinds and their metabolic changes; and the five chief vitamins, which are considered in turn, each in a separate chapter.

The book is the outcome of a series of lectures delivered at the Pennsylvania State College, and is designed for the use of students who possess some preliminary knowledge of chemistry. To quote from the preface, "the comprehensive nature of the work has made it impossible to cover all the phases of agricultural science in the manner they merit". Nevertheless, it is evident that the authors have achieved their object, namely, "to leave the reader with the knowledge that agricultural and biological science is in a state of flux, and that the solution of many problems awaits the future investigator".

The text is enlivened by many pictures of men, animals, and places, and each chapter ends with a short list of reference books (mainly American) for general reading. Several well-chosen graphic chemical formulae and equations are given. The special chapters on vitamins furnish useful summaries of modern knowledge, but it is rather surprising that no portrait of Sir F. Gowland Hopkins is reproduced in this section. Fitting tribute is paid to the work of the late Dr. H. P. Armsby, formerly Director of the Pennsylvania Agricultural Experiment Station, for his pioneering invention of the energy conception in the scientific feeding of animals. The book is well printed, and a good index of contents is provided.

F. H.

* * *

NELSON'S WEST INDIAN READERS.

First Primer, 32 pp., price 7*d*. Second Primer, 48 pp., price 9*d*. Compiled by J. O. Cutteridge. *T. Nelson & Sons, Ltd.*

In these two primers the standard of the previous "Readers" has been well maintained. The books are printed in large clear type and are profusely illustrated with pictures which should be particularly helpful for teaching purposes.

G. G.

INSECT PESTS OF FARM, GARDEN AND ORCHARD.

By Sanderson and Peairs, 3rd Edition, 1931. *John Wiley & Sons, Inc.*, New York. 31*s*., pp. 568.

This new and enlarged edition of a standard, practical, entomological handbook will be specially appreciated by those who are particularly interested in the study and control of crop pests within the geographical area covered by the text. The book which deals with the crop pests of the United States of America covers also the pests of a number of tropical and sub-tropical crops, and the principles involved in insect control would in many instances apply to the same and related crops under tropical conditions. In addition to the pests of the farm, garden and orchard as indicated in the title, the book contains chapters on the control of pests of stored grain, domestic and household pests and pests attacking domestic stock, poultry, and even man himself. Like the previous edition the volume is clearly printed, well illustrated and attractively bound.

H. A. B.

* * *

AIDS TO ZOOLOGY.

By Harry Lister, M.SC., F.Z.S., 1929. Price 3*s*. 6*d*. By post 3*d*. extra. pp. viii+209.

A Dictionary of Greek and Latin combining forms used in Zoological Names. By Edmund C. Jarger, 1931. Price 8*s*. 6*d*. pp. 157.

These books were published by *Bailliere, Tindall & Cox*, 7 & 8, Henrietta Street, Covent Gardens, London, W.C.2.

The Aids to Zoology aims at giving in a short space an outline of the Zoological knowledge necessary for the Intermediate Science, Agriculture and Horticulture and the first M.B. (Cambridge & London) Examinations. It also covers the syllabus of the School Certificate Examinations. It is not intended to replace the larger manuals and text books which treat the subject more fully, and are much more expensive to buy.

The Dictionary of Greek and Latin forms is intended to aid the student in understanding and appreciating the value of the Greek and Latin elements in the names used in the biological science. Such names are often a dread and stumbling block to the young student to whom they are a disagreeable adjunct to an otherwise interesting subject of study. This dictionary containing some 2000 of these combining forms should be interesting and useful in helping the student to understand the relation of the scientific names to some characteristic structure or habit of the organism named.

H. A. B.

* * *

WONDERS OF THE EARTH'S CRUST.

By H. E. Taylor. *Sir Isaac Pitman & Sons, Ltd.*, London., pp. 216, price 2*s*. 6*d*.

An introduction to geology which is written in simple language and is liberally supplied with excellent photographs and diagrams.

D. W. D.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Vibrating Screens for "Cush-Cush".

The straining of juice for the separation of the greater part of its bagacillo or "cush-cush" is being given more and more attention nowadays. Different apparatus, more or less complicated and more or less efficient, are in use for the purpose. Some types require considerable attention.

A type of apparatus that is coming into favour is the Vibrating Screen, which has been installed in factories in Cuba, South America, Natal and elsewhere. Reports regarding its operation have been particularly satisfactory, and by some it is considered to solve the question of the continuous screening of the raw juice previous to clarification.

A British make of screen which is claimed to be particularly suitable for the elimination of the bagacillo from the juice is the "Johnson" High Speed Vibrating Screening Machine, made by Messrs. C. H. Johnson & Sons, Ltd., Smedley, Manchester. In this the vibrating unit operates in oil and is mounted in a cast-iron oil-proof container. The screen is fitted with phosphor bronze, copper, steel or iron wire mesh, woven or crimped, square or loop, in sizes to suit particular requirements. The meshes are easily and quickly interchangeable. An automatic feeding hopper can be fitted if desired. The apparatus can be driven from existing shafting or be supplied complete with electric motor or gasoline engine.—(*Inter. Sugar Jour.*, Vol. XXXIV, No. 404, August, 1932.)

* * *

Growth Failure of Sugar-Cane in Hawaii. *C. W. Carpenter.*

The terms "root disease complex" and "growth failure complex" have been used to designate those obscure causes of growth failure which are resident in the soil. Disturbances of the normal root functions of sugar-cane that are reflected by decreased growth of the aerial portions can be classed under two heads: (1) nutritional disturbances: lack of balance of available nutrients with deficiencies of certain essential or toxic elements, and (2) parasitic organisms, such as fungous root-rot caused by *Pythium aphanidermatum*, and root injury by nematodes.

Experience so far gained in Hawaii has removed apprehension of weakening of the standard varieties with respect to root parasites; practically all cane land in Hawaii is now devoted to canes resistant to actual root-rot. The problem of growth failure has been practically reduced to a question of the treatment of infertile soils; root-attacking organisms are perhaps still involved in the complex of poor growth in some areas, but apparently as incidental and not as primary factors; the primary cause is undoubtedly malnutrition.

This being the case, correct fertilizer practice must be employed with certain varieties; thus, in the old days when not much emphasis was placed on nitrogen fertilizers, the Lahaina variety yielded well, but began to fail spectacularly when large amounts of nitrogen began to be employed. On the other hand, the varieties P.O.J. 2878 and H. 109 are not so subject to this depressing effect of nitrogen.

The general conclusion from all experience to date seems to be that, when sugar-cane does not grow well on a particular soil, the fault will lie, first, in the absence of a well-balanced supply of plant food and moisture, and second, in an inherent weakness of the variety, which may be changed to a more resistant one. — (*Facts About Sugar*, Vol. XXVII, No. 6, June 1932.)

* * *

Unrefined Sugar. *H. C. S. De Whalley.*

The attention paid to the vitamin content of foods may be overdone, and if we choose a well mixed diet we are practically assured of an adequate supply. Cane and beet sugar contain little or no vitamins, both in the "raw" and in the "refined" state, yet certain faddists have advocated unrefined sugar in preference to the refined product, on the assumption that refined sugar causes dental decay. This is not the case, as sugar stimulates a copious flow of saliva in which it is quickly dissolved, and the solution is swallowed so rapidly that bacterial growth is not favoured. Unrefined sugar was found to contain cane fibres, hordes of micro-organisms and masses of sugar lice. Refined sugar, on the other hand, was found to be a clean, dry, sound food of exceptional chemical and bacteriological purity.—(*Chem. & Ind.*, Vol. LI, 1932, No. 36, p. 739).

* * *

Germany Producing Sugar from Waste Wood.

A new use for waste wood from forests is reported by the Deutsche Bergin Actien Gesellschaft fur Kohle und Erdoelchemie, at Rheinau, near Mannheim. The company has departed from its former field of activity, the hydrogenation of coal and oil, and is now occupied with the producing of sugar from waste wood in forests. The technical side had been considered solved for some time, both as regards the manufacture of fodder products and fodder mixtures, and the further refining of the "wood-sugar" to grape-sugar or dextroglucose. The economic success of the process also appeared to be assured in itself, but further developments depended upon a favourable wood price, upon a successful public introduction of the new and cheap fodder, and finally, the financing of extensions of the Rheinau plant, or the erection of new large factories elsewhere. The "wood-sugar" produced by the process of the company is regarded as a cheap basic material for the production of yeast alcohol, and other products of fermentation.—(*Chem. & Ind.* Vol. LI, 1932, No. 35, p. 727.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Report of the Sudan Government Chemist, 1931.

This report includes work carried out at the Wellcome Tropical Research Laboratories at Khartoum and the associated laboratories at Gezira and Atbara. Much of the work is connected with public hygiene and forensic chemistry, but agricultural research has been attacked from several angles, with results which are of wide interest. The examination of the exchangeable capacity of Gezira clays shows the effect of salt-containing subsoils, while the work on the movement of soil salts under irrigation is a closely related field problem. The fluctuation of soil moisture naturally claims attention, and this is being investigated in selected parts of the irrigated area under cotton. Certain soil improvers, namely gypsum, calcium chloride, ferrous sulphate and sulphur, with and without ammonium sulphate, have been tested with regard to their effects on cotton and its soil. It was found that ammonium sulphate has no effect on the moisture content of the soil, but all four soil improvers showed a more or less uniform increase in the water penetration when compared with control plots. The residual effect of these soil improvers on the soil texture is also under investigation. Soil nitrates were found to be unusually high during 1930-31 when the cotton crop was exceptionally bad.

Analytical data from cotton plants affected with leaf curl as compared with healthy plants indicated that the cause of this disease could not be ascribed to deficiency of any major mineral element, although a slightly lower silica content was found in affected leaves. A general conclusion was reached that there seemed to be a tendency for plants to show greater symptoms of leaf curl wherever they might be expected to grow quickly during part or all of an irrigated cycle, vigorous plants being most readily affected.

Chemical examination of fodder grasses showed a low mineral content when compared with good European pastures. The most striking deficiency is nitrogen (protein), the average content being only 40 per cent. of a good natural pasture. The average phosphorous content is also low, being about 50 per cent. of good pasture, and pica has been reported from the White Nile Province, where all grasses showed a marked phosphate deficiency.

* * *

Another Vitamin ?

At a meeting of the Biochemical Society on June 11th., L. W. Mapson read a paper entitled "Evidence of a Dietary Principle Stimulating General Growth and Lactation". He showed that a substance is present in fresh ox liver which stimulates the growth of rats maintained on a full synthetic diet to approximately twice the normal rate of the control animals. The lactation of females was also stimulated. This growth-promoting principle is distinct from the known accessory food factors. Whether the substance active in promoting the growth rate is identical with that stimulating lactation remains to be determined. A peculiar point is that the growth response has been transmitted from parent to offspring by the feeding of liver to the parents, the stimulation of growth being greater under such conditions than when the liver is fed directly to young animals.—(*Chem. and Ind.*, Vol. LI, No. 25, 1932, p. 535.)

* * *

New Uses for Rubber.

Interesting particulars are given in *The Times Trade and Engineering Supplement* of 6th August, of the progress of "Dunlopillo", the cellular air cushion rubber which is being made at Fort Dunlop. For the manufacture of this material latex is shipped straight from the estates to England in its natural condition, and in the factory the latex, after the addition of some necessary ingredients, is subjected to a whisking process which produces numerous tiny air cells before being vulcanized. It is claimed that the use of this material for upholstering has effected a saving in cost of as much as 33.3 per cent., whilst the practicability of using layers of different density allows rigidity to be combined with any required cushioning power. The London General Omnibus Company, after extensive tests, has adopted the material for use in a fleet of 250 new omnibuses, whilst the whole seating of the Shakespeare Memorial Theatre has been carried out in cellular air cushion rubber. Another article in the same issue deals with other uses which are being found for rubber, whilst the Malayan Rubber Research Institute is endeavouring to find an outlet for a carbohydrate material known as quebrachitol, occurring to the extent of about 0.5 per cent. in latex, and of which some 10,000 tons are wasted annually on the plantations.—(*Chem. and Ind.*, Vol. LI, No. 33, p. 683.)

* * *

Continuous Measurement of pH with Quinhydrone Electrodes. C. C. Coons.

The quinhydrone electrode has proved itself an excellent means for obtaining continuous pH measurements or pH control.

It now is being successfully employed within the range 0-8.0 and sometimes to 9.0 pH if oxidizing or reducing agents causing serious error in the potential are absent. In most cases the electrode is accurate within 0.05 up to 7.5 pH. Above this point the error gradually increases, becoming 0.1 at 8.0 pH and approximately 0.2 at 9.0 pH. For industrial applications the electrode must be installed in a special apparatus which must embody certain essential features. The author describes, with illustrations, such an apparatus, for details of which the original paper* should be consulted. —(*Facts About Sugar*, Vol. XXVII, No. 6, June 1932.)

*(*Ind. Eng. Chem.*, Analyt. Ed., Vol. IV (1932), No. 2, pp. 175-178.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR :—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
25th Aug. ..	6	5¼	11	2¼
1st Sept. ..	6	4½	11	1½
8th Sept. ..	6	3	11	0
15th Sept. ..	5	10½	10	7½
22nd Sept. ..	5	9½	10	6¼
29th Sept. ..	5	10½	10	7½
6th Oct. ..	5	10½	10	7½
13th Oct. ..	6	0	10	8¼
(*8th Oct.*, 1931) ..	6	11	10	7½

Rather unsettled conditions have prevailed in the market which experienced a set-back, values in the United Kingdom showing a decline of 4½*d.* per cwt. This turn in the trend, following a period of steady to firm markets is not attributed to any new important development in the general situation but appears to have been the outcome of the disheartening lack of activity in Raw Sugars. In view of the satisfactory movement of Refined in America during the past weeks and the absence of any replacement buying of Raw Sugars it was generally anticipated that there would be an early re-entry of Refiners into the market. This development, however, failed to materialise and has led to the liquidation of open positions on the Futures Exchange by disheartened "long" interests whilst holders of parcels in store and Sugars in very prompt positions have shown a disposition to make concessions. There is a general belief in America that supplies and requirements for the remainder of the year may prove to be very closely balanced and the prospect of a tight statistical situation is being freely discussed. The publication of Dr. Mikusch's estimates of the European Beet crops reveals a reduction of 586,000 tons as against last season's estimates.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
31st Aug.	2 15/16
7th Sept.	3
14th Sept.	2 11/16
21st Sept.	2 9/16
28th Sept.	2 21/32
5th Oct.	2½
13th Oct.	2 13/32
(*7th Oct.*, 1931)	3

Since our last report rubber prices have shown irregular fluctuations, a spell of great activity being experienced early in September which, however, was not maintained. The future of the market would appear to depend on the course of events in America where, apparently, the accumulated stocks of rubber are in the hands of only a very limited number of manufacturers. In London, heavy liquidation has taken place and at times the market has found it somewhat difficult to reabsorb the quantities offered.

* * *

COCOA :—The cocoa market is still being influenced by political and other conditions, and at the moment is much weaker. So far very little information has come to hand regarding the Accra crop which should now be in full swing. Price for this grade of cocoa may be quoted at 29*s.*, to 30*s.* c.i.f. and locally $7.50 a fanega is being paid.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Limited.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*
26th Aug. ..	6.45	8.75
2nd Sept. ..	6.57	8.90
9th Sept. ..	6.38	8.80
16th Sept. ..	5.88	8.75
23rd Sept. ..	6.13	—
30th Sept. ..	5.95	—
7th Oct. ..	5.87	—
13th Oct. ..	5.64	—
(*9th Oct.*, 1931) ..	4.56	7.10

After further rises in prices the market received a severe shock when it was learnt that the estimates issued by the American Bureau of Statistics were 600,000 bales higher than anticipated. The immediate effect of the Report was a break in the price of cotton in New York of one cent per lb. This was carried further by extensive long liquidation by disappointed bulls. Developments in the textile trade, especially in the U.S.A. have, however, been favourable.

* * *

TEA :—Latest averages include Indian 8.48*d.*, Ceylon 8.48*d.*, and Java 4.72*d.* Stocks of tea, though still slightly above 200 million pounds are reduced from 1931 and 1930.

* * *

COFFEE :—Jamaica has been quoted at 195*s.* to 213*s.* 6*d.* per cwt., Kenya at 67*s.* 6*d.* and Costa Rica from 84*s.* to 156*s.*

* * *

BANANAS :—The demand has been affected somewhat owing to the large supply of pears. Jamaicas are unchanged at £21 5*s.* per ton delivered London, and £21 nearest railway station, and Brazilians at £19 per ton nearest station. The total imports for the eight months ended 31st August, were 11,714,510 bunches, as compared with 10,533,217 bunches for the same period last year.—(*West India Committee Circular*, 15th September.)